United States
Department of
Agriculture

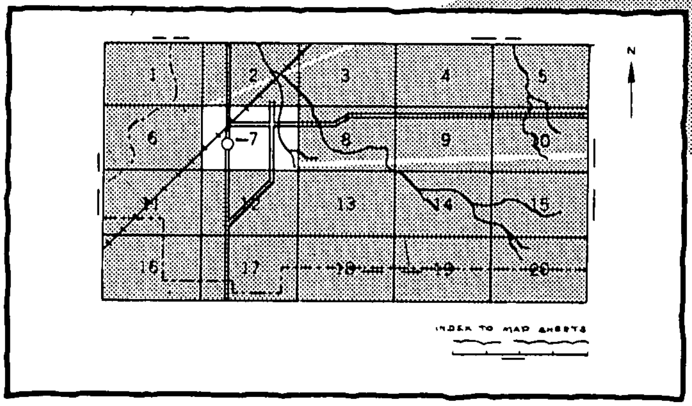
Soil
Conservation
Service

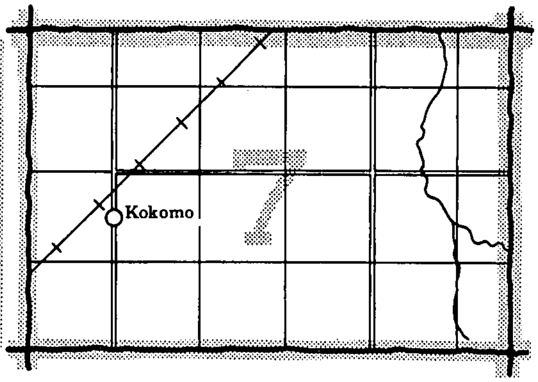
In Cooperation with
South Dakota
Agricultural
Experiment
Station

Soil Survey of Faulk County, South Dakota

HOW TO USE

1. Locate your area of interest on the "Index to Map Sheets" (the last page of this publication).





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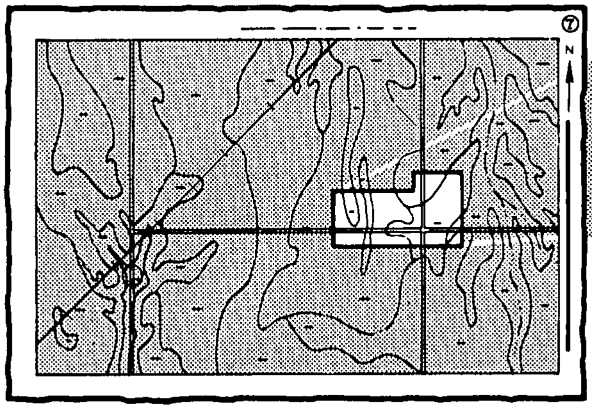

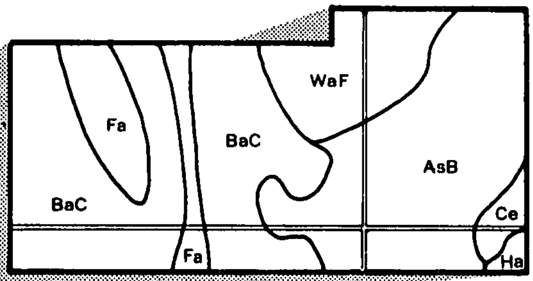

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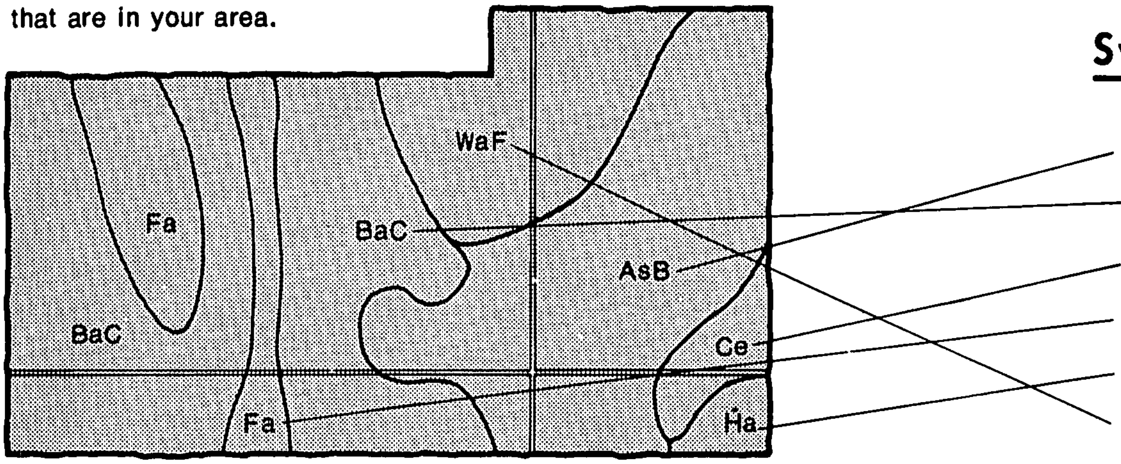

Symbols

AsB
BaC
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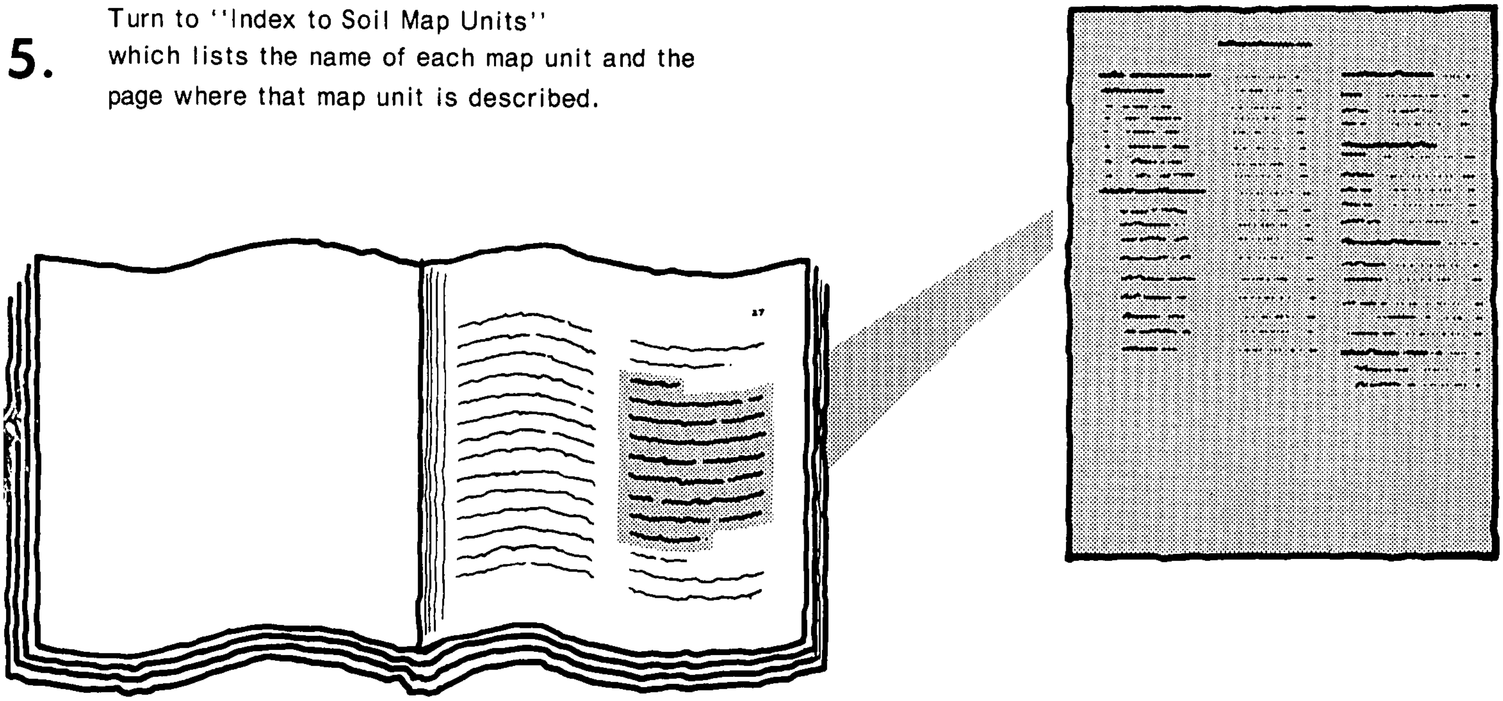
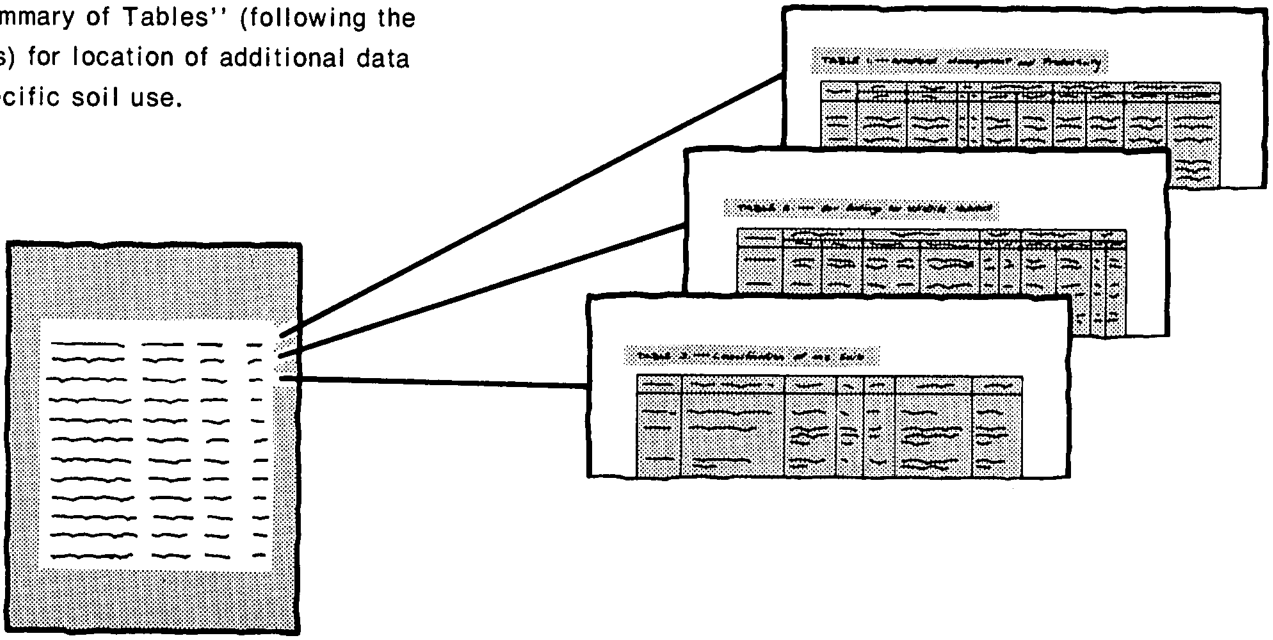
THIS SOIL SURVEY

5. Turn to "Index to Soil Map Units" which lists the name of each map unit and the page where that map unit is described.



6. See "Summary of Tables" (following the Contents) for location of additional data on a specific soil use.



7. Consult "Contents" for parts of the publication that will meet your specific needs. This survey contains useful information for farmers or ranchers, foresters or agronomists; for planners, community decision makers, engineers, developers, builders, or homebuyers; for conservationists, recreationists, teachers, or students; for specialists in wildlife management, waste disposal, or pollution control.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other federal agencies, state agencies including the Agricultural Experiment Stations, and local agencies. The Soil Conservation Service has leadership for the federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, or age.

This survey was made cooperatively by the Soil Conservation Service and the South Dakota Agricultural Experiment Station. It is part of the technical assistance furnished to the Faulk County Conservation District. Financial assistance was furnished by the Faulk County Commissioners and the South Dakota Department of Revenue. Major fieldwork was performed in the period 1977-81. Soil names and descriptions were approved in 1982. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1982.

Soil maps in this survey may be copied without permission. Enlargement of these maps, however, could cause misunderstanding of the detail of mapping. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a larger scale.

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Foreword

This soil survey contains information that can be used in land-planning programs in Faulk County, South Dakota. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations inherent in the soil or hazards that adversely affect the soil, improvements needed to overcome the limitations or reduce the hazards, and the impact of selected land uses on the environment.

This soil survey is designed for many different users. Farmers, ranchers, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to insure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Soil Conservation Service or the Cooperative Extension Service.

R. D. Swenson

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State Conservationist
Soil Conservation Service

Soil Survey of
Faulk County, South Dakota

By Kenneth F. Miller, Soil Conservation Service

Soils surveyed by Kenneth F. Miller, Janet L. Oertly, Kendall K. Olson,
and Bruce O. Kunze, Soil Conservation Service

United States Department of Agriculture, Soil Conservation Service,
in cooperation with
the South Dakota Agricultural Experiment Station

FAULK COUNTY is in the north-central part of South Dakota (fig. 1). It has a total area of 638,720 acres, which includes about 2,000 acres of water. Faulkton is the county seat. Other towns and communities are Chelsea, Cresbard, Miranda, Onaka, Orient, Rockham, Seneca, Wecota, and Zell.

About 55 percent of the acreage in the county is cropland, and 45 percent supports native grass (*3*). Spring wheat, oats, corn, and alfalfa are the main crops. Farming is diversified. Livestock and livestock products are the main sources of income, but income from cash crops also is important.

General Nature of the County

This section gives general information concerning the county. It describes climate; physiography, relief, and drainage; settlement; farming; and natural resources.

Climate

Prepared by the National Climatic Center, Asheville, North Carolina.

Faulk County is usually warm in summer, but hot spells are frequent and cool days occasional. The county is very cold in winter, when arctic air frequently surges over the area. Most of the precipitation falls during the warm period, especially late in spring and early in summer. Snowfall is normally not heavy, and it is blown into drifts, so that much of the ground is free of snow.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Faulkton, South Dakota, in the period 1951 to 1978. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter the average temperature is about 16 degrees F, and the average daily minimum temperature is 5 degrees. The lowest temperature on record, which occurred at Faulkton on January 15, 1971, is -37 degrees. In summer the average temperature is about 71 degrees, and the average daily maximum temperature is 85 degrees. The highest recorded temperature, which occurred at Faulkton on August 13, 1965, is 113 degrees.

Growing degree days are shown in table 1. They are equivalent to "heat units." During the month, growing degree days accumulate by the amount that the average

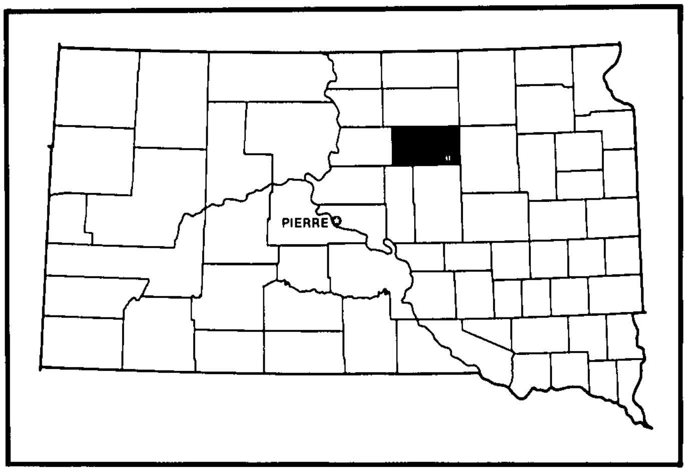

Figure 1.—Location of Faulk County in South Dakota.

temperature each day exceeds a base temperature (40 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

The total annual precipitation is 18.01 inches. Of this, 14 inches, or about 80 percent, usually falls in April through September. The growing season for most crops falls within this period. In 2 years out of 10, the rainfall in April through September is less than 11 inches. The heaviest 1-day rainfall during the period of record was 4.20 inches at Faulkton on July 28, 1953. Thunderstorms occur on about 40 days each year, and most occur in summer.

Average seasonal snowfall is about 26 inches. The greatest snow depth at any one time during the period of record was 28 inches. On an average of 34 days, at least 1 inch of snow is on the ground. The number of such days varies greatly from year to year. Blizzards occur several times each winter.

The average relative humidity in midafternoon is about 60 percent. Humidity is higher at night, and the average at dawn is about 80 percent. The sun shines 70 percent of the time possible in summer and 60 percent in winter. The prevailing wind is from the west-northwest. Average windspeed is highest, 13 miles per hour, in April.

Physiography, Relief, and Drainage

Faulk County is in two physiographic areas. The central and western parts are on the Coteau du Missouri (*4*). The relief in these parts of the county dominantly is undulating to hilly. The landscape is characterized by many potholes or depressions, and the drainage pattern is poorly defined.

The eastern part of the county is in the James Basin portion of the Central Lowland. The relief mainly is nearly level and undulating. The drainage pattern is fairly well defined. The principal drainageways are the North and South Forks of Snake Creek and their tributaries. They merge into Snake Creek, which flows east to the James River.

Land elevation ranges from 2,015 feet above sea level in the southwestern part of the county to about 1,355 feet in the eastern part.

Settlement

Faulk County was named after Andrew J. Faulk, the third Governor of the Dakota Territory. It was established by the Territorial Legislature in 1873. The original county included all of the present county, except for the part east of the 99th meridian, or the approximate area of the two eastern tiers of townships. It also included a small area along the western border now outside the county. The present boundaries were established in 1883 (*7*).

The first permanent settlers arrived in 1882. They settled in Lafoon Township, on the south side of South Fork Snake Creek. They came mainly from states to the east and from Germany and the Scandinavian countries. The county seat was moved from the former town of Lafoon to Faulkton after the extension of railroads into the county.

The population of the county was 4,062 by 1890 and peaked at 6,895 in 1930. It declined to 3,298 by 1980. Faulkton, the largest town, has a population of 981. Chelsea has a population of 41; Cresbard, 221; Onaka, 70; Orient, 87; Rockham, 52; and Seneca, 103.

Railroads served the county from 1886 to the early 1970's. U.S. Highway 212, South Dakota Highways 45 and 47, and County Highway 20 are the main highways. Most rural areas are served by all-weather roads, which carry traffic to centers of trade.

Farming

Farming is the principal enterprise in Faulk County. About 65 percent of the farm income is derived from the sale of livestock and livestock products (*12*). The first settlers grew mostly small grain. Eventually, fertility was reduced and wind erosion and water erosion were prevalent. The Faulk County Conservation District was organized in 1967 to alleviate this situation. Grass was seeded on eroding cropland, and trees were planted to provide protection for farmsteads and to help control wind erosion.

In 1978, there were 399 farms in Faulk County. The farms average about 1,500 acres in size. The trend is toward fewer and larger farms.

In 1978, wheat was harvested from 71,682 acres, oats from 29,561 acres, corn from 25,093 acres, barley from 21,288 acres, and rye from 9,603 acres (*12*). About half of the corn was used for silage. Alfalfa hay was harvested from 57,186 acres. Millet, sorghum, and sunflowers are also grown in the county.

Natural Resources

Soil is the most important natural resource in the county. It provides a growing medium for crops and for the grass grazed by livestock. Other natural resources are water, sand and gravel, and wildlife.

The principal sources of water for domestic use and for livestock are deep glacial aquifers and bedrock aquifers. Shallow glacial aquifers also provide water (*6*). Water quantity generally is greater in the deep wells, but the quality is poor because of a high content of soluble salts. Dugouts in areas of Heil, Nishon, Parnell, and Tonka soils provide additional water for livestock and wildlife. Lake Faulkton provides opportunities for fishing, boating, and waterfowl hunting. Intermittent lakes and sloughs also provide hunting opportunities. The drainageways flow only intermittently and provide water only during periods of snowmelt and high rainfall.

Sand and gravel are deposited in scattered areas throughout the county. These deposits range from a few feet to more than 20 feet in thickness (*4*). They consist mainly of fine to coarse sand and some gravel, silt, and clay. Because of an excessive amount of fine rock fragments, such as shale, chalk, and clay ironstone, the sand and gravel are unsuitable as concrete aggregate or as construction material. They are suitable, however, as subgrade material for roads and as bituminous aggregate.

How This Survey Was Made

This survey was made to provide information about the soils in the survey area. The information includes a description of the soils and their location and a discussion of the suitability, limitations, and management of the soils for specified uses. Soil scientists observed the steepness, length, and shape of slopes; the general pattern of drainage; the kinds of crops and native plants growing on the soils; and the kinds of bedrock. They dug many holes to study the soil profile, which is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biologic activity.

The soils in the survey area occur in an orderly pattern that is related to the geology, the landforms, relief, climate, and the natural vegetation of the area. Each kind of soil is associated with a particular kind of landscape or with a segment of the landscape. By observing the soils in the survey area and relating their position to specific segments of the landscape, a soil scientist develops a concept, or model, of how the soils were formed. Thus, during mapping, this model enables the soil scientist to predict with considerable accuracy the kind of soil at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, acidity, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. The system of taxonomic classification used in the United States is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpreted the data from these analyses and tests as well as the field-observed characteristics and the soil properties in terms of expected behavior of the soils under different uses. Interpretations for all of the soils were field tested through observation of the soils in different uses under different levels of management. Some interpretations are modified to fit local conditions, and new interpretations sometimes are developed to meet local needs. Data were assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management were assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can state with a fairly high degree of probability that a given soil will have a high water table within certain depths in most years, but they cannot assure that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Map Unit Composition

A map unit delineation on a soil map represents an area dominated by one major kind of soil or an area dominated by several kinds of soil. A map unit is identified and named according to the taxonomic classification of the dominant soil or soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural objects. In common with other natural objects, they have a characteristic variability in their properties. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of soils of other taxonomic classes. Consequently, every map unit is made up of the soil or soils for which it is named and some soils that belong to other taxonomic classes. These latter soils are called inclusions or included soils.

Most inclusions have properties and behavioral patterns similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting (similar) inclusions. They may or may not be mentioned in the map unit descriptions. Other inclusions, however, have properties and behavior divergent enough to affect use or require different management. These are contrasting (dissimilar) inclusions. They generally occupy small areas and cannot be shown separately on the soil maps because of the scale used in mapping. The inclusions of contrasting soils are mentioned in the map unit descriptions. A few inclusions may not have been observed and consequently are not mentioned in the descriptions, especially where the soil pattern was so complex that it was impractical to make enough observations to identify all of the kinds of soil on the landscape.

The presence of inclusions in a map unit in no way diminishes the usefulness or accuracy of the soil data. The objective of soil mapping is not to delineate pure taxonomic classes of soils but rather to separate the landscape into segments that have similar use and management requirements. The delineation of such landscape segments on the map provides sufficient information for the development of resource plans, but onsite investigation is needed to plan for intensive uses in small areas.

General Soil Map Units

The general soil map at the back of this publication shows the soil associations in this survey area. Each association has a distinctive pattern of soils, relief, and drainage. Each is a unique natural landscape. Typically, an association consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one association can occur in another but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one association differ from place to place in slope, depth, drainage, and other characteristics that affect management.

The associations on the general soil map of this county are described on the pages that follow. The names of the associations do not coincide exactly with those on the general soil maps in the published surveys of Hand and Edmunds Counties, which are adjacent to this county. Differences are the result of changes in the application of the soil classification system and variations in the design of map units.

Soil Descriptions

1. Williams-Bowbells association

Well drained and moderately well drained, nearly level and undulating, loamy soils on uplands and in upland swales

This association is on glacial till plains characterized by rises interrupted by narrow swales and depressions. Slopes generally are short. They are mainly undulating, but some areas are nearly level. The drainage pattern is poorly defined in most areas, but it is well defined along drainageways.

This association makes up about 46 percent of the county. It is about 45 percent Williams soils, 20 percent Bowbells soils, and 35 percent minor soils (fig. 2).

The well drained Williams soils are on rises. In this association they generally have a slope of 0 to 6 percent. Typically, the surface layer is dark grayish brown loam. The subsoil is dark grayish brown, brown, and light olive brown clay loam. It is calcareous in the lower part. The underlying material is pale yellow, mottled, calcareous clay loam.

The moderately well drained Bowbells soils are on foot slopes and in swales. Slopes range from 0 to 3 percent. Typically, the surface layer is dark gray loam. The subsoil is dark grayish brown and grayish brown clay loam. The underlying material is light brownish gray and light yellowish brown, mottled, calcareous clay loam.

Minor in this association are Harriet, Lehr, Manning, Miranda, Niobell, Nishon, Noonan, Parnell, Ranslo, Tonka, Wabek, Zahill, and Zahl soils. The poorly drained Harriet and somewhat poorly drained Ranslo soils are on flood plains. They have a sodium affected subsoil. The somewhat poorly drained Miranda and moderately well drained Niobell and Noonan soils also have a sodium affected subsoil. They are on flats in the uplands. The somewhat excessively drained Lehr and Manning and excessively drained Wabek soils are underlain by gravelly material. They are on terraces. The poorly drained Nishon and Tonka and very poorly drained Parnell soils are in upland depressions. The well drained Zahill and Zahl soils are on the steeper slopes. Also of minor extent are Raber and Vida soils, which are similar to the William soils and are in similar positions on the landscape.

About 62 percent of this association is cropland. Corn, small grain, and alfalfa are the main crops. Some of the steeper areas along the larger drainageways support native grasses and are used for grazing. Controlling erosion and conserving moisture are the main concerns of management if the major soils are cropped. The association is suited to cultivated crops and to tame pasture and hay, range, and openland wildlife habitat.

2. Williams-Bowbells-Vida association

Well drained and moderately well drained, nearly level to moderately sloping, loamy soils on uplands and in upland swales

This association is on glacial till plains characterized by ridges, knolls, swales, and depressions. Slopes generally are undulating and gently rolling but are nearly level in some areas. They are steeper along entrenched drainageways. In most areas the drainageways terminate in small depressions. The drainage pattern is poorly defined in these areas. It is well defined, however, along

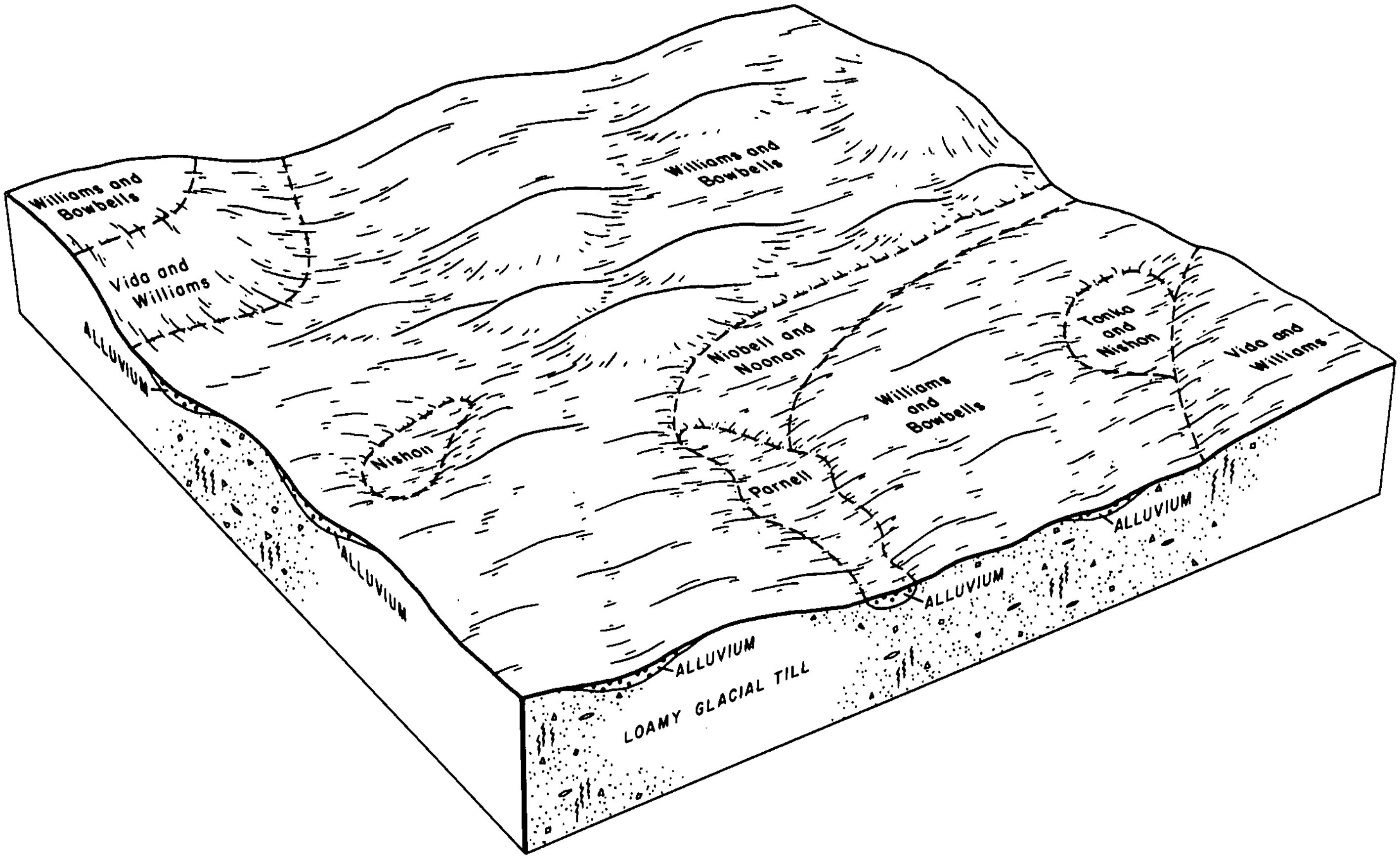

Figure 2.—Pattern of soils and parent material in the Williams-Bowbells association.

the larger drainageways. Stones and boulders are on some of the ridges and knolls.

This association makes up about 27 percent of the county. It is about 35 percent Williams soils, 20 percent Bowbells soils, 10 percent Vida soils, and 35 percent minor soils.

The well drained Williams soils are on the mid and lower parts of the landscape. In this association they generally have a slope of 0 to 9 percent. Typically, the surface layer is dark grayish brown loam. The subsoil is dark grayish brown, brown, and light olive brown clay loam. It is calcareous in the lower part. The underlying material is pale yellow, mottled, calcareous clay loam.

The moderately well drained Bowbells soils are on foot slopes and in swales. Slopes range from 0 to 3 percent. Typically, the surface layer is dark gray loam. The subsoil is dark grayish brown and grayish brown clay loam. The underlying material is light brownish gray and light yellowish brown, mottled, calcareous clay loam.

The well drained Vida soils are on knolls, ridges, and the upper side slopes. Slopes range from 2 to 9 percent. Typically, the surface layer is dark grayish brown loam. The subsoil is brown and light brownish gray clay loam. It is calcareous in the lower part. The underlying material is light brownish gray, mottled, calcareous loam.

Minor in this association are Cavo, Harriet, Niobell, Nishon, Noonan, Parnell, Ranslo, Tonka, Zahill, and Zahl soils. The moderately well drained Cavo, Niobell, and Noonan soils are on foot slopes and flats in the uplands. They have a sodium affected subsoil. The poorly drained Harriet and somewhat poorly drained Ranslo soils also have a sodium affected subsoil. They are on flood plains. The poorly drained Nishon and Tonka and very poorly drained Parnell soils are in upland depressions. The well drained Zahill and Zahl soils are on the steeper slopes.

About 59 percent of this association is range. Some areas are used as cropland. Corn, small grain, and alfalfa are the main crops. Conserving moisture, controlling erosion, and maintaining fertility are the main concerns in managing the major soils for crops. The association is suited to cultivated crops and to tame pasture and hay, range, and openland and rangeland wildlife habitat.

3. Williams-Zahill-Bowbells association

Well drained and moderately well drained, nearly level to *steep, loamy soils on uplands and in upland swales*

This association is on uplands characterized by many knolls, hills, and ridges intermingled with swales that terminate in deep depressions. Slopes generally are rolling but in some areas are nearly level to moderately sloping and in others are steep. The drainage pattern is poorly defined in areas where the drainageways terminate in small depressions. It is well defined, however, along the larger drainageways. Stones and boulders are on the knolls and ridges in most areas. They are numerous on some of the ridges.

This association makes up about 4 percent of the county. It is about 40 percent Williams soils, 25 percent Zahill soils, 25 percent Bowbells soils, and 10 percent minor soils (fig. 3).

The well drained Williams soils are on the mid and lower parts of the landscape. Slopes range from 0 to 15 percent. Typically, the surface layer is dark grayish brown loam. The subsoil is dark grayish brown, brown, and light olive brown clay loam. It is calcareous in the lower part. The underlying material is pale yellow, mottled, calcareous clay loam.

The well drained Zahill soils are on the upper side slopes and on knolls and ridges. Slopes range from 6 to 40 percent. Typically, the surface layer is dark grayish brown, calcareous loam. The underlying material is grayish brown and light brownish gray, mottled, calcareous clay loam.

The moderately well drained Bowbells soils are on foot slopes and in swales. Slopes range from 0 to 3 percent. Typically, the surface layer is dark gray loam. The subsoil is dark grayish brown and grayish brown clay loam. The underlying material is light brownish gray and light yellowish brown, calcareous clay loam.

Minor in this association are Lehr, Niobell, Noonan, Parnell, Tonka, Vida, Wabek, and Zahl soils. The somewhat excessively drained Lehr and excessively drained Wabek soils are underlain by sand and gravel.

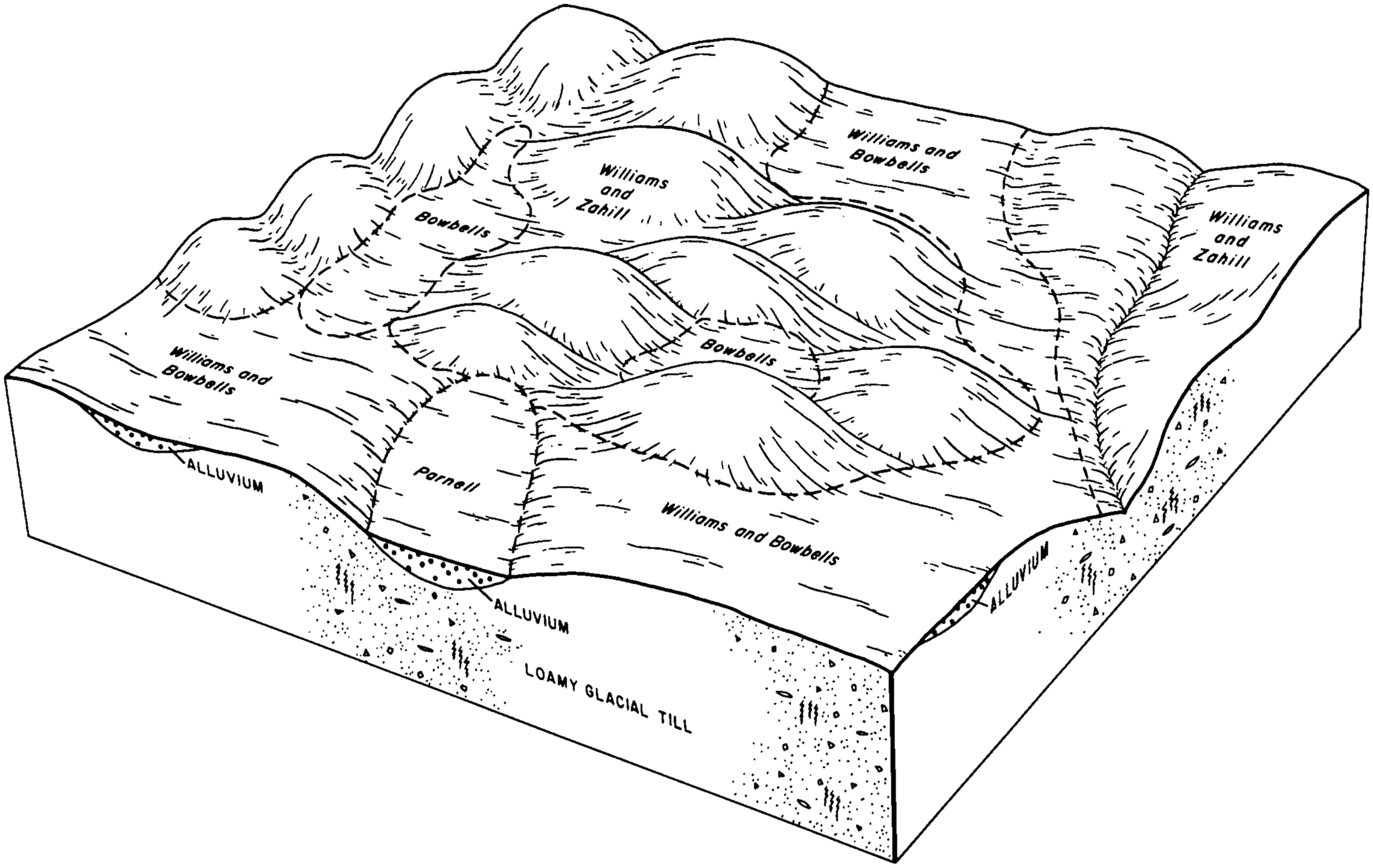

Figure 3.—Pattern of soils and parent material in the Williams-Zahill-Bowbells association.

They are on ridges. The moderately well drained Niobell and Noonan soils are on foot slopes and flats. They have a sodium affected subsoil. The very poorly drained Parnell and poorly drained Tonka soils are in depressions. The well drained Vida and Zahl soils are in positions on the landscape similar to those of the Williams and Zahill soils.

Most of this association is range. Some of the less sloping areas are used for forage crops. Measures that control erosion are the main management needs. The association is suited to range and rangeland wildlife habitat. It generally is suited to cultivated crops, but erosion is a hazard and the steep slopes and scattered stones and boulders on the surface in some areas are limitations. In many areas the soils are too steep or too stony for cultivated crops.

4. Max-Arnegard-Zahl association

Well drained, nearly level to moderately steep, loamy soils on uplands and in upland swales

This association is on glacial till plains characterized by knolls, ridges, swales, and depressions. Slopes are mainly nearly level and undulating but are moderately sloping to moderately steep on ridges and along entrenched drainageways. The drainage pattern is poorly defined in areas where drainageways terminate in small depressions. It is well defined, however, along the larger drainageways. Scattered stones are on the surface in some areas. They are numerous on some of the ridges.

This association makes up about 6 percent of the county. It is about 40 percent Max soils, 22 percent Arnegard soils, 20 percent Zahl soils, and 18 percent minor soils.

The Max soils are on the mid and upper side slopes and on broad flats. Slopes range from 2 to 15 percent. Typically, the surface layer is dark grayish brown loam. The subsoil is brown and light yellowish brown loam. It is calcareous in the lower part. The underlying material is light brownish gray and pale yellow, calcareous loam. It is mottled in the lower part.

The Arnegard soils are in slightly concave areas, on the lower foot slopes, and in swales. Slopes range from 0 to 3 percent. Typically, the surface layer is dark gray loam. The subsoil is dark grayish brown and brown loam. The underlying material is light brownish gray, calcareous loam. It is mottled in the lower part.

The Zahl soils are on knolls and ridgetops. Slopes range from 3 to 20 percent. Typically, the surface layer is grayish brown loam. The underlying material is grayish brown, light brownish gray, and pale yellow, calcareous loam. It is mottled in the lower part.

Minor in this association are Bowdle, Harriet, Lehr, Manning, Miranda, Niobell, Nishon, Noonan, Parnell, Ranslo, and Tonka soils. The well drained Bowdle and somewhat excessively drained Lehr and Manning soils are underlain by gravelly material. They are on terraces. The poorly drained Harriet and somewhat poorly drained Ranslo soils are on flood plains. They have a sodium affected subsoil. The moderately well drained Niobell and Noonan and somewhat poorly drained Miranda soils also have a sodium affected subsoil. They are on foot slopes and flats in the uplands. The very poorly drained Parnell and poorly drained Nishon and Tonka soils are in depressions.

About percent 60 of this association is cropland. Corn, small grain, and alfalfa are the main crops. The steeper areas along the drainageways support native grasses and are used for grazing. Conserving moisture, improving fertility, and controlling erosion are the main concerns in managing the major soils for crops. The association generally is suited to cultivated crops and to tame pasture and hay, range, and openland wildlife habitat.

5. Bryant-Grassna association

Well drained and moderately well drained, nearly level and gently sloping, silty soils on uplands and in upland swales

This association is on glacial till plains characterized by long, smooth slopes, wide swales, and a few scattered depressions. In most areas the drainage pattern is poorly defined, but it is well defined along the larger drainageways.

This association makes up about 2 percent of the county. It is about 50 percent Bryant soils, 25 percent Grassna soils, and 25 percent minor soils.

The well drained Bryant soils are on rises. Slopes range from 0 to 6 percent. Typically, the surface layer is dark grayish brown silt loam. The subsoil is dark grayish brown, brown, and pale brown silty clay loam. It is calcareous in the lower part. The underlying material is light yellowish brown, calcareous silt loam. It is mottled in the lower part.

The moderately well drained Grassna soils are in swales. Slopes range from 0 to 6 percent. Typically, the surface layer is dark gray silt loam. The subsoil is dark grayish brown silty clay loam and light olive brown silt loam. The underlying material is light yellowish brown and pale yellow, calcareous silt loam. It is mottled in the lower part.

Minor in this association are Bowbells, Mondamin, Tonka, Williams, and Zahill soils. The moderately well drained Bowbells soils are in swales. They contain more sand throughout than the Grassna soils. Mondamin soils contain more clay in the subsoil than the Bryant soils. They are on high plateaus. The poorly drained Tonka soils are in depressions. The well drained Williams soils contain more sand throughout than the Bryant soils. They are in positions on the landscape similar to those of the Bryant soils. The well drained Zahill soils are on ridges and knolls.

About 88 percent of this association is cropland. Corn, small grain, and alfalfa are the main crops. Conserving moisture and controlling erosion are the main concerns

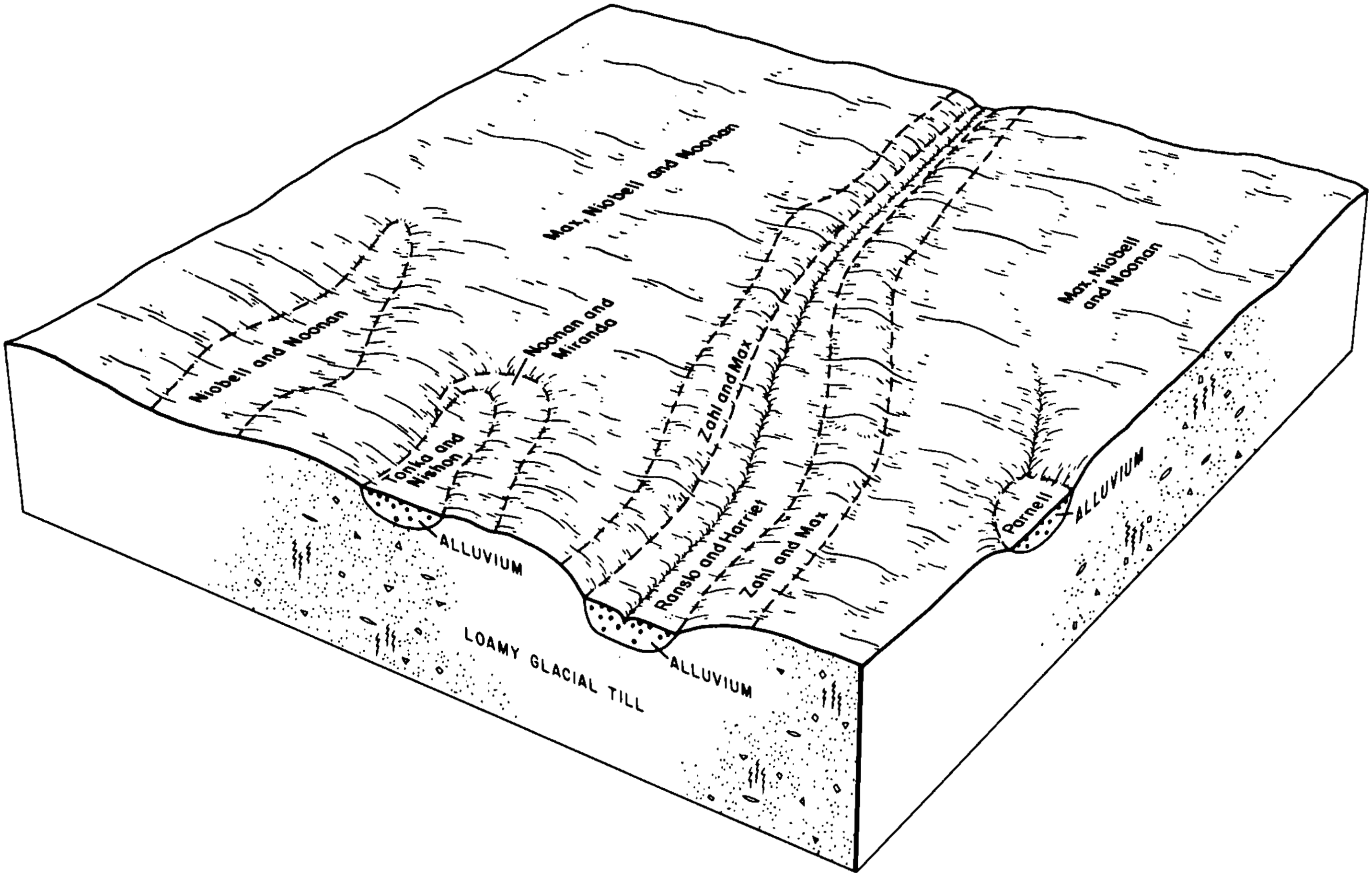

Figure 4.—Pattern of soils and parent material in the Max-Niobell-Noonan association.

in managing the major soils for crops. The association is suited to cultivated crops and to tame pasture and hay, range, and openland wildlife habitat.

6. Max-Niobell-Noonan association

Well drained, gently sloping and moderately sloping, loamy soils and moderately well drained, nearly level and gently sloping, sodium affected, loamy soils; on uplands

This association is on glacial till plains characterized by knolls, swales, and depressions. Slopes mainly are nearly level and undulating but are moderately sloping on some ridges and near depressions. They are steeper along some entrenched drainageways.

This association makes up about 10 percent of the county. It is about 30 percent Max soils, 15 percent Niobell soils, 12 percent Noonan soils, and 43 percent minor soils (fig. 4).

The well drained Max soils are on the mid and upper side slopes. In this association they have a slope of 2 to 9 percent. Typically, the surface layer is dark grayish brown loam. The subsoil is brown and light yellowish brown loam. It is calcareous in the lower part. The underlying material is light brownish gray and pale yellow, calcareous loam. It is mottled in the lower part.

The moderately well drained Niobell soils are on the lower side slopes, in swales, and on flats. Slopes range from 0 to 6 percent. Typically, the surface layer is dark grayish brown loam. The upper part of the subsoil is grayish brown loam. The lower part is dark grayish brown and brown clay loam. The underlying material is grayish brown and light brownish gray, calcareous loam. It is mottled in the lower part.

The moderately well drained Noonan soils are on the lower side slopes, in swales, and on flats. Slopes range from 0 to 6 percent. Typically, the surface layer is grayish brown loam. The subsurface layer is light brownish gray loam. The subsoil is brown clay loam and light yellowish brown loam. The underlying material is light gray and pale yellow, calcareous loam.

Minor in this association are Bowdle, Harriet, Heil, Lehr, Manning, Miranda, Nishon, Parnell, Ranslo, Tonka, and Zahl soils. The well drained Bowdle and somewhat excessively drained Lehr and Manning soils are underlain by gravelly material. They are on terraces. The poorly drained Harriet and somewhat poorly drained Ranslo soils are on flood plains. They have a sodium affected subsoil. The poorly drained Heil, Nishon, and Tonka and very poorly drained Parnell soils are in upland depressions. The somewhat poorly drained Miranda soils are in small pits and depressions in the uplands. The well drained Zahl soils are on upland ridges and knolls.

About 56 percent of this association is cropland. Corn, small grain, and alfalfa are the main crops. The steeper areas along the larger drainageways support native grasses and are used for grazing. Conserving moisture, improving tilth, and controlling erosion are the main concerns in managing the major soils for crops. The association is suited to cultivated crops and to tame pasture and hay, range, and openland wildlife habitat. The sodium affected subsoil in the Niobell and Noonan soils is a limitation.

7. Noonan-Miranda association

Moderately well drained and somewhat poorly drained, nearly level and undulating, sodium affected, loamy soils on uplands

This association is on glacial till plains, mainly on flats and rises interrupted by a few swales and many shallow depressions. In most areas drainageways terminate in small depressions. The drainage pattern is poorly defined in these areas. It is well defined, however, along the larger drainageways. Scattered stones are on the surface in some areas.

This association makes up about 2 percent of the county. It is about 45 percent Noonan soils, 30 percent Miranda soils, and 25 percent minor soils.

The moderately well drained Noonan soils are on broad flats and in swales. Slopes range from 0 to 6 percent. Typically, the surface layer is grayish brown loam. The subsurface layer is light brownish gray loam. The subsoil is brown clay loam and light yellowish brown loam. The underlying material is light gray and pale yellow, calcareous loam.

The somewhat poorly drained Miranda soils are in pits and small depressions. Slopes range from 0 to 5 percent. Typically, the surface layer is dark gray loam. The subsurface layer is gray loam. The subsoil is dark grayish brown and grayish brown clay loam. The underlying material is light olive brown and pale olive, calcareous clay loam.

Minor in this association are Arnegard, Harriet, Heil, Max, Nishon, Ranslo, and Tonka soils. The well drained Arnegard and Max soils do not have a sodium affected subsoil. Arnegard soils are in swales, and Max soils are on the higher, more convex parts of the uplands. The poorly drained Harriet and somewhat poorly drained Ranslo soils are on narrow flood plains. The poorly drained Heil, Nishon, and Tonka soils are in upland depressions. Also of minor extent are Niobell soils, which are similar to the Noonan soils and are in similar positions on the landscape.

About 90 percent of this association supports native grasses and is used for grazing. Small grain and alfalfa are grown in a few areas. Measures that increase the rate of water intake, conserve moisture, and improve tilth are the main management needs if the major soils are cultivated. The association is suited to cultivated crops and to openland wildlife habitat, tame pasture and hay, range, and rangeland wildlife habitat. The sodium affected subsoil in the major soils is a limitation.

8. La Prairie-Zahill-Lehr association

Moderately well drained to somewhat excessively drained, nearly level to steep, loamy soils on flood plains, terraces, and uplands

This association is on flood plains, valley sides, and terraces and terrace scarps along Snake Creek and its tributaries. In many areas the nearly level, smooth slopes on the flood plains are broken by drainage channels and meander scars. The slopes on the valley sides mainly are moderately sloping to steep and are short and convex. Those on the terraces and terrace scarps mainly are nearly level and gently sloping. Scattered stones are on knolls and ridges in some areas.

This association makes up about 3 percent of the county. It is about 40 percent La Prairie soils, 15 percent Zahill soils, 15 percent Lehr soils, and 30 percent minor soils.

The moderately well drained La Prairie soils are on the flood plains. Slopes range from 0 to 3 percent. Typically, the surface layer is dark gray loam. The subsoil is dark gray, calcareous silt loam. The underlying material is grayish brown, calcareous silt loam.

The well drained Zahill soils are on the valley sides. Slopes range from 6 to 40 percent. Typically, the surface layer is dark grayish brown, calcareous loam. The underlying material is grayish brown and light brownish gray, mottled, calcareous clay loam.

The somewhat excessively drained Lehr soils are on broad flats, on ridges, and on terrace scarps. Slopes range from 0 to 6 percent. Typically, the surface layer is dark gray loam. The subsoil is dark grayish brown loam. The underlying material is grayish brown and light brownish gray, calcareous gravelly loamy sand.

Minor in this association are Arnegard, Bowbells, Bowdle, Harriet, Max, Ranslo, Tally, and Williams soils. The well drained Arnegard and moderately well drained Bowbells soils are on foot slopes and in upland swales. The well drained Bowdle soils are 20 to 40 inches deep over gravelly material. They are on terraces. The poorly drained Harriet and somewhat poorly drained Ranslo soils are on the lowest part of the flood plains. They have a sodium affected subsoil. The well drained Max and Williams soils formed in loamy glacial till on uplands. The well drained Tally soils are on uplands. They are not underlain by gravelly material. Also of minor extent are Manning and Wabek soils, which are similar to the Lehr soils and are on the terraces and terrace scarps.

About 75 percent of this association is range. Some areas are used as cropland. Small grain and alfalfa are the main crops. They are grown mainly on the larger tracts of the La Prairie soils. Conserving moisture and controlling erosion are the main concerns in managing the major soils for crops. The association is suited to cultivated crops and to tame pasture and hay, range, and rangeland wildlife habitat. The moderately sloping to steep slope of the Zahill soils and the droughtiness of the Lehr soils are limitations. Trees and shrubs near the channels in areas of the La Prairie soils provide excellent cover for wildlife and livestock.

Detailed Soil Map Units

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps and tables, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit, or soil, is given under "Use and Management of the Soils."

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil and identifies the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer or of the underlying material, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the underlying material. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Bowdle loam, 0 to 3 percent slopes, is one of several phases in the Bowdle series.

Some map units are made up of two or more major soils. These map units are called soil complexes. A *soil complex* consists of two or more soils that occur as areas so intricately mixed or so small that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Williams-Bowbells loams, 0 to 3 percent slopes, is an example.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. These dissimiliar soils are described in each map unit. Also, some of the more unusual or strongly contrasting soils are identified by a special symbol on the soil maps.

This survey includes some *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Pits, gravel, is an example. Some miscellaneous areas are large enough to be delineated on the soil maps. Some that are too small to be delineated are identified by a special symbol on the soil maps.

The names of some map units on the detailed soil maps do not coincide exactly with those in the published surveys of Edmunds and Hand Counties, which are adjacent to this county. Differences are the result of variations in the design of map units and changes in the application of the soil classification system.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of Tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils.

Soil Descriptions

Bb—Bowbells loam. This deep, moderately well drained, nearly level soil is in swales on uplands. It is occasionally flooded for very brief periods. Areas generally are irregular in shape and 5 to 110 acres in size. Slopes are smooth and slightly concave.

Typically, the surface layer is dark gray loam about 11 inches thick. The subsoil is dark grayish brown and grayish brown, friable clay loam about 16 inches thick. The underlying material to a depth of 60 inches is light brownish gray and light yellowish brown, mottled, calcareous clay loam.

Included with this soil in mapping are small areas of Niobell, Nishon, Noonan, Tonka, and Williams soils. These soils make up less than 20 percent of any one mapped area. Niobell and Noonan soils have a sodium affected subsoil. They are on the lower parts of the landscape. The poorly drained Nishon and Tonka soils are in depressions. The well drained Williams soils are on the higher parts of the landscape.

Fertility and organic matter content are high in the Bowbells soil. Tilth is good. Available water capacity is high. Permeability is moderate in the subsoil and moderately slow in the underlying material. A seasonal high water table is at a depth of 4 to 6 feet. Runoff is slow. The shrink-swell potential is moderate.

Most of the acreage is cropland. This soil is suited to cultivated crops and to tame pasture and hay. Alfalfa, intermediate wheatgrass, and smooth bromegrass grow well. Measures that conserve moisture during dry periods are the main management needs. Leaving crop residue on the surface and including grasses and legumes in the cropping system are examples. Fieldwork is delayed in some years because of the wetness caused by runoff from the adjacent uplands.

This soil is suited to windbreaks and environmental plantings. All climatically suited trees and shrubs grow well, especially those that require an abundant supply of moisture.

This soil is suited to native grasses, but very few areas are used for range. The native vegetation dominantly is big bluestem, western wheatgrass, and green needlegrass. Overused areas are dominated by western wheatgrass and Kentucky bluegrass.

The capability unit is IIc-3; Overflow range site.

BoA—Bowdle loam, 0 to 3 percent slopes. This well drained, nearly level soil is on terraces. It is moderately deep over gravelly material. Areas are irregular in shape and 5 to 160 acres in size. Slopes are long and smooth.

Typically, the surface layer is dark gray loam about 7 inches thick. The subsoil is dark grayish brown and grayish brown, friable loam about 14 inches thick. The underlying material to a depth of 60 inches is light brownish gray and pale brown, calcareous gravelly sandy loam and gravelly sand. In places loamy glacial till is below a depth of 40 inches.

Included with this soil in mapping are small areas of the somewhat excessively drained Lehr and Manning soils on slight rises. These soils make up less than 10 percent of any one mapped area. Lehr soils are 14 to 20 inches deep over gravelly material. Manning soils contain more sand in the subsoil than the Bowdle soil.

Fertility is medium and organic matter content high in the Bowdle soil. Tilth is good. Because of the porous underlying material, root development is limited and the soil is somewhat droughty. Available water capacity is low or moderate. Permeability is moderate in the subsoil and rapid in the gravelly underlying material. Runoff is slow.

Most of the acreage is cropland. This soil is suited to cultivated crops, but it is droughty. Measures that conserve moisture are the main management needs. Examples are leaving crop residue on the surface and including grasses and legumes in the cropping system.

This soil is suited to tame pasture and hay. Only those grasses that are drought resistant, however, are suitable. Crested wheatgrass and pubescent wheatgrass are examples.

This soil is suited to range. The native vegetation dominantly is green needlegrass, western wheatgrass, and needleandthread. Overused areas are dominated by western wheatgrass, needleandthread, and blue grama. After continued overuse, blue grama, Kentucky bluegrass, and weeds dominate the site.

This soil is suited to windbreaks and environmental plantings, but the droughtiness is a limitation. Trees and shrubs can be established, but optimum growth, survival, and vigor are unlikely.

The capability unit is IIIs-2; Silty range site.

BrA—Bryant-Grassna silt loams, 0 to 2 percent slopes. These deep, nearly level soils are on uplands. The well drained Bryant soil is on the higher convex parts of the landscape. The moderately well drained Grassna soil is in swales and on the lower concave parts of the landscape. It is occasionally flooded for very brief periods. Areas are irregular in shape and 3 to more than 200 acres in size. They are 65 to 75 percent Bryant soil and 15 to 25 percent Grassna soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Bryant soil is dark grayish brown silt loam about 6 inches thick. The subsoil is dark grayish brown, brown, and pale brown, friable silty clay loam about 15 inches thick. In the lower part it is calcareous and has accumulations of carbonate that extend into the underlying material. The underlying material to a depth of 60 inches is light yellowish brown, calcareous silt loam. It is mottled in the lower part. In some areas, the surface layer is less than 5 inches thick and lime is nearer the surface. In other areas the subsoil contains more clay.

Typically, the surface layer of the Grassna soil is dark gray silt loam about 7 inches thick. The subsoil is about 31 inches of dark grayish brown and light olive brown, friable silty clay loam and silt loam. The underlying material to a depth of 60 inches is light yellowish brown and pale yellow, calcareous silt loam. It is mottled in the lower part. In some areas the subsoil and underlying material contain more sand.

Included with these soils in mapping are small areas of Tonka and Williams soils. These included soils make up less than 15 percent of any one mapped area. The poorly drained Tonka soils are in depressions. The well drained Williams soils are on slight rises near the edges of some mapped areas. They formed in loamy glacial till.

Fertility is medium and organic matter content moderate in the Bryant soil. Fertility and organic matter content are high in the Grassna soil. Tilth is good in both soils. Permeability is moderate. Available water capacity is high. The Grassna soil has a water table at a depth of 4 to 6 feet during wet periods. Runoff is slow on both soils. The shrink-swell potential is moderate in the Grassna soil.

Most of the acreage is cropland. These soils are suited to cultivated crops and to alfalfa, intermediate wheatgrass, and smooth bromegrass for tame pasture and hay. Measures that conserve moisture are the main management needs. Examples are tillage practices that leave crop residue on the surface. Because the Grassna soil receives runoff from the adjacent uplands, planting and harvesting are delayed in some wet years.

These soils are suited to native grasses, but only a few areas are used for range. The native vegetation on the Bryant soil dominantly is green needlegrass, western wheatgrass, and needleandthread. That on the Grassna soil dominantly is big bluestem, western wheatgrass, and green needlegrass. Overused areas are dominated by western wheatgrass, blue grama, needleandthread, and Kentucky bluegrass.

These soils are suited to windbreaks and environmental plantings. All climatically suited trees and shrubs grow well on the Bryant soil, except for those that require an abundant supply of moisture. Those that require an abundant moisture supply grow especially well on the Grassna soil.

The Bryant soil is in capability unit IIc-2, Silty range site; the Grassna soil in capability unit IIc-3, Overflow range site.

BrB—Bryant-Grassna silt loams, 2 to 6 percent slopes. These deep, nearly level and gently sloping soils are on uplands. The well drained Bryant soil is on the higher convex parts of the landscape. The moderately well drained Grassna soil is in swales. It is occasionally flooded for very brief periods. Areas are irregular in shape and 5 to more than 600 acres in size. They are 55 to 65 percent Bryant soil and 25 to 35 percent Grassna soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Bryant soil is dark grayish brown silt loam about 6 inches thick. The subsoil is dark grayish brown, brown, and pale brown, friable silty clay loam about 15 inches thick. In the lower part it is calcareous and has accumulations of carbonate that extend into the underlying material. The underlying material to a depth of 60 inches is light yellowish brown, calcareous silt loam. It is mottled in the lower part. In places the subsoil contains more clay. In some areas, the surface layer is less than 5 inches thick and lime is nearer the surface.

Typically, the surface layer of the Grassna soil is dark gray silt loam about 7 inches thick. The subsoil is about 31 inches of dark grayish brown and light olive brown, friable silty clay loam and silt loam. The underlying material to a depth of 60 inches is light yellowish brown and pale yellow, calcareous silt loam. It is mottled in the lower part. In places the subsoil and underlying material contain more sand.

Included with these soils in mapping are small areas of Tonka and Williams soils. These included soils make up less than 15 percent of any one mapped area. The poorly drained Tonka soils are in depressions. The well drained Williams soils are on the higher parts of the landscape near the edges of some mapped areas. They formed in loamy glacial till.

Fertility is medium and organic matter content moderate in the Bryant soil. Fertility and organic matter content are high in the Grassna soil. Tilth is good in both soils. Permeability is moderate. Available water capacity is high. The Grassna soil has a water table at a depth of 4 to 6 feet during wet periods. Runoff is medium on the Bryant soil and slow on the Grassna soil. The shrink-swell potential is moderate in the Grassna soil.

Most of the acreage is cropland. These soils are suited to cultivated crops and to alfalfa, intermediate wheatgrass, and smooth bromegrass for tame pasture and hay. Measures that conserve moisture and control erosion are the main management needs. Examples are tillage practices that leave crop residue on the surface. Contour farming, grassed waterways, and terraces also can help to control erosion, but the slopes in some areas are too short or too irregular for contouring and terracing. Planting and harvesting are delayed on the Grassna soil during some wet periods.

These soils are suited to native grasses, but only a few areas are used for range. The native vegetation on the Bryant soil dominantly is green needlegrass, western wheatgrass, and needleandthread. That on the Grassna soil dominantly is big bluestem, western wheatgrass, and green needlegrass. Overused areas are dominated by western wheatgrass, blue grama, needleandthread, and Kentucky bluegrass.

These soils are suited to windbreaks and environmental plantings. All climatically suited trees and shrubs grow well on the Bryant soil, except for those that require an abundant supply of moisture. Those that require an abundant moisture supply grow especially well on the Grassna soil.

The Bryant soil is in capability unit IIe-1, Silty range site; the Grassna soil in capability unit IIc-3, Overflow range site.

Ha—Harriet silt loam. This deep, poorly drained, level soil is on flood plains. It is occasionally flooded for long periods. Many areas are dissected by shallow drainageways and stream channels. Areas are long and narrow and are 5 to 160 acres in size. Slopes are concave or smooth.

Typically, the surface layer is gray silt loam about 3 inches thick. The subsoil is dark gray and gray, very firm silty clay about 8 inches thick. The underlying material to a depth of 60 inches is olive gray and pale olive, calcareous silty clay and silty clay loam. It has spots and nests of salts in the upper part.

Included with this soil in mapping are small areas of La Prairie and Ranslo soils on slight rises on the flood plains. These soils make up less than 15 percent of any one mapped area. The moderately well drained La

Prairie soils do not have a sodium affected subsoil. Ranslo soils are somewhat poorly drained.

Fertility is low or medium and organic matter content moderate in the Harriet soil. This soil contains detrimental amounts of sodium salts. Tilth is poor. The sodium affected subsoil restricts root penetration. Available water capacity is moderate. Permeability is very slow. A water table is within a depth of 1 foot during wet periods. Runoff is slow. The shrink-swell potential is high.

Nearly all of the acreage supports native grasses and is used for grazing. This soil is suited to range. The native vegetation dominantly is western wheatgrass and saltgrass. Overused areas are dominated by saltgrass, foxtail barley, thin stands of western wheatgrass, and weeds. Grazing when the soil is wet causes surface compaction and puddling, both of which result in a decrease in the extent of desirable grasses. Many areas are potential sites for excavated ponds.

This soil generally is unsuited to cultivated crops and to windbreaks and environmental plantings. It is suited to tame pasture and hay, but the dense and compact subsoil, the high content of salts, and the flooding severely limit the choice of suitable species. Tall wheatgrass is the best suited species.

The capability unit is VIw-4; Saline Lowland range site.

He—Heil silt loam. This deep, poorly drained, level soil is in shallow depressions in the uplands. It is ponded during periods of snowmelt and heavy rainfall. Areas are circular or long and narrow and are 3 to 90 acres in size. Slopes are concave.

Typically, the surface layer is gray silt loam about 2 inches thick. The subsoil is dark gray, very firm and firm silty clay about 21 inches thick. The underlying material to a depth of 60 inches is dark gray and light olive gray, calcareous silty clay and clay loam. In the lower part it is mottled and has accumulations of carbonate. In some areas the surface layer is more than 4 inches thick.

Included with this soil in mapping are small areas of Parnell and Tonka soils. These soils make up less than 10 percent of any one mapped area. They are in the lower part of some depressions. They do not have a sodium affected subsoil. Also, their surface layer is thicker than that of the Heil soil.

Fertility is medium and organic matter content moderate in the Heil soil. This soil contains detrimental amounts of sodium salts. Tilth is poor. Available water capacity is moderate. Permeability is very slow. A seasonal high water table is within a depth of 1 foot most of the year. As much as 1 foot of water ponds on the surface during some wet periods. Runoff is ponded. The shrink-swell potential is high.

Most of the acreage supports native grasses. A few areas are farmed along with adjacent areas. This soil is suited to range. The native vegetation dominantly is western wheatgrass and sedges. Overused areas are dominated by Kentucky bluegrass and saltgrass. Sedges increase in extent during wet periods, and foxtail barley and curlycup gumweed increase in extent during dry periods. The surface layer is puddled if the range is grazed during wet periods. This puddling results in an increase in the extent of the less desirable plants. Many areas are potential sites for excavated ponds.

This soil generally is unsuited to cultivated crops and to windbreaks and environmental plantings. The dense, compact subsoil and the ponding are the main limitations.

This soil is suited to tame pasture and hay, but the choice of tame pasture plants is limited because natural drainage is restricted, the surface layer is thin, and the subsoil dense and compact. Garrison creeping foxtail and reed canarygrass are examples of suitable pasture plants.

The capability unit is VIs-1; Closed Depression range site.

La—La Prairie loam. This deep, moderately well drained, nearly level soil is on stream terraces and flood plains. It is subject to rare flooding for brief periods. Areas are 10 to 100 acres in size and irregular in shape.

Typically, the surface layer is dark gray loam about 15 inches thick. The subsoil is dark gray, very friable, calcareous silt loam about 8 inches thick. The underlying material to a depth of 60 inches is grayish brown, calcareous silt loam. In some areas it is stratified with thin layers of loamy and sandy material. In other areas, the surface layer is sandy loam and strata of sand are in the subsoil.

Included with this soil in mapping are small areas of Bowdle, Lehr, and Ranslo soils. These soils make up less than 20 percent of any one mapped area. The well drained Bowdle and somewhat excessively drained Lehr soils are on the higher parts of the landscape. Bowdle soils are 20 to 40 inches deep over gravelly material, and Lehr soils are 14 to 20 inches deep over gravelly material. The somewhat poorly drained Ranslo soils are in small depressions. They have a sodium affected subsoil.

Fertility and organic matter content are high in the La Prairie soil. Tilth is good. Available water capacity is high. Permeability is moderate. A water table is at a depth of 3.5 to 6.0 feet during wet periods. Runoff is slow. The shrink-swell potential is moderate.

Most of the acreage is cropland. This soil is suited to cultivated crops and to alfalfa, intermediate wheatgrass, and smooth bromegrass for tame pasture and hay (fig. 5). The main management needs in cultivated areas are measures that conserve moisture during dry periods. Leaving crop residue on the surface is an example. Floodwater delays planting in some years, but in most years the additional moisture is beneficial and flood damage is minor.

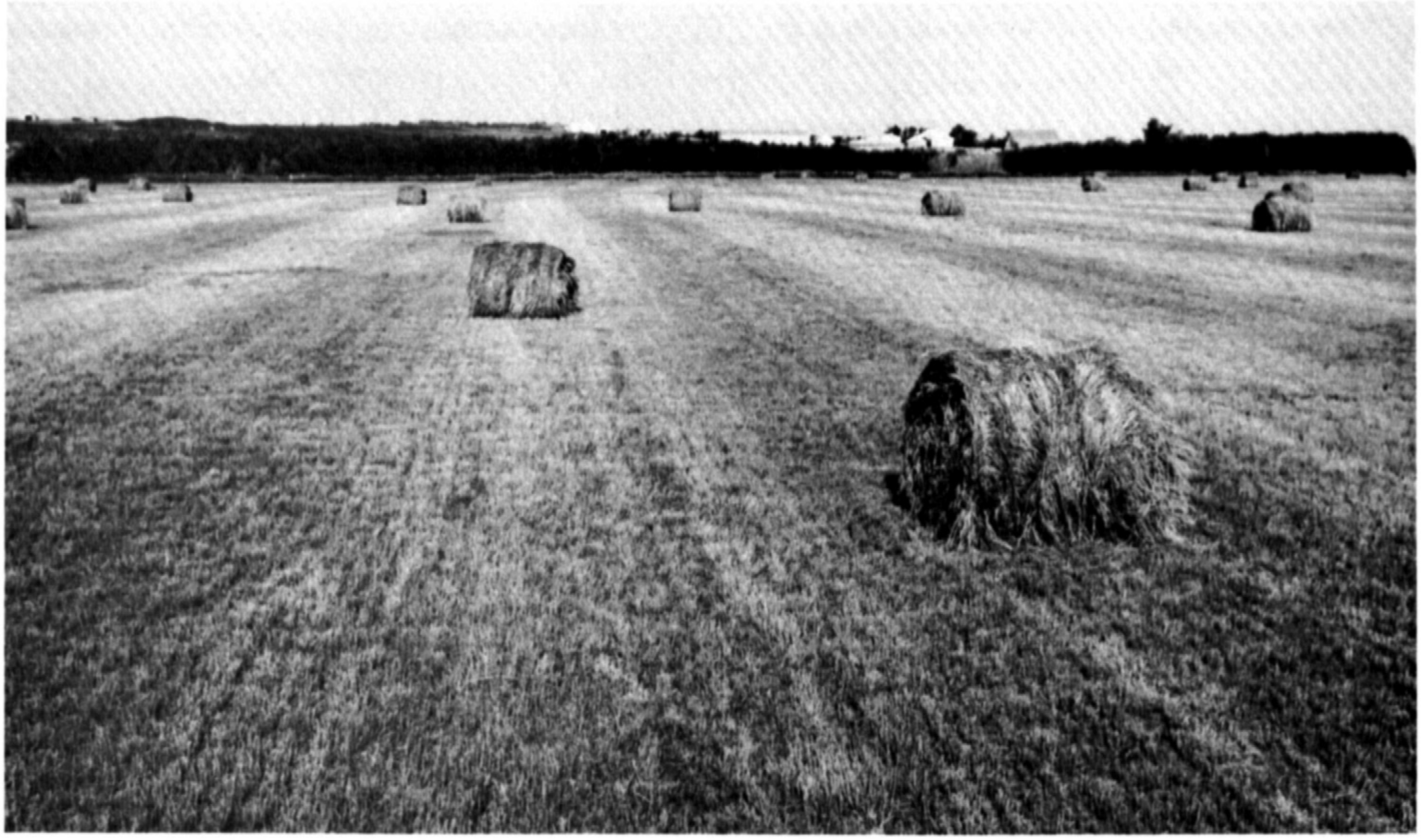

Figure 5.—An area of La Prairie loam used for tame hay.

This soil is suited to range. The native vegetation dominantly is big bluestem, green needlegrass, and western wheatgrass. Overused areas are dominated by Kentucky bluegrass and western wheatgrass. After continued overuse, Kentucky bluegrass and weeds dominate the site.

This soil is suited to windbreaks and environmental plantings. The trees and shrubs that require an abundant supply of moisture grow especially well.

The capability unit is IIc-3; Overflow range site.

Lb—La Prairie loam, channeled. This deep, moderately well drained, nearly level soil is on flood plains that are dissected into many small tracts by narrow channels. It is frequently flooded. Areas are long and narrow and are 10 to 150 acres in size.

Typically, the surface layer is dark gray loam about 15 inches thick. The subsoil is dark gray, very friable, calcareous silt loam about 8 inches thick. The underlying material to a depth of 60 inches is grayish brown, calcareous silt loam. In some areas it is stratified with thin layers of loamy and sandy material. In other areas, the surface layer is sandy loam and strata of sand are in the subsoil.

Included with this soil in mapping are small areas of Bowbells, Harriet, and Ranslo soils. These soils make up less than 20 percent of any one mapped area. Bowbells soils are in swales near the uplands. They contain more clay in the subsoil than the La Prairie soil. The poorly drained Harriet and somewhat poorly drained Ranslo soils occur as areas intermingled with some areas of the La Prairie soil. They have a sodium affected subsoil.

Fertility and organic matter content are high in the La Prairie soil. Tilth is good. Available water capacity is high. Permeability is moderate. A water table is at a depth of 3.5 to 6.0 feet during wet periods. Runoff is slow. The shrink-swell potential is moderate.

Most of the acreage supports native grasses and is used for grazing or wildlife habitat. This soil is suited to range. The native vegetation dominantly is big bluestem and lesser amounts of green needlegrass, switchgrass, and western wheatgrass. Overused areas are dominated by western wheatgrass, Kentucky bluegrass, and weeds. Deciduous trees provide protection for wildlife and livestock in some areas.

Because of the meandering channels and the flooding, this soil generally is unsuited to cultivated crops. In areas that are accessible to farm machinery, it is suited to tame pasture and hay. Alflafa, intermediate wheatgrass, and smooth bromegrass grow well. Silt and debris deposited by floodwater in some years damage pasture plants and hinder haying.

This soil is suited to windbreaks and environmental plantings. All climatically suited trees and shrubs grow well. They can be planted by hand. Because of the meandering stream channels, however, they generally cannot be planted by machine.

The capability unit is VIw-1; Overflow range site.

LeA—Lehr loam, 0 to 3 percent slopes. This somewhat excessively drained, nearly level soil is on outwash plains and terraces. It is shallow over gravelly material. Areas are irregular in shape and 10 to 80 acres in size. Slopes are smooth or slightly convex.

Typically, the surface layer is dark gray loam about 5 inches thick. The subsoil is dark grayish brown, friable loam about 10 inches thick. The underlying material to a depth of 60 inches is grayish brown and light brownish gray, calcareous gravelly loamy sand. In places the subsoil contains more sand. In some areas the depth to gravelly material is less than 14 inches.

Included with this soil in mapping are small areas of the well drained Bowdle and Tally soils. These soils make up less than 10 percent of any one mapped area. Bowdle soils are 20 to 40 inches deep over gravelly material. They are slightly lower on the landscape than the Lehr soil. Tally soils are on slight rises. They contain more sand in the subsoil than the Lehr soil and do not have gravelly material within a depth of 40 inches.

Fertility is medium or low and organic matter content moderate in the Lehr soil. Tilth is good. Available water capacity is low. Permeability is moderately rapid in the subsoil and rapid in the gravelly underlying material. Runoff is slow. The porous underlying material restricts the development of plant roots.

Most of the acreage is cropland. This soil is suited to cultivated crops, but it is droughty because it is shallow to gravelly material. It is best suited to early maturing small grain. Measures that conserve moisture are the main management needs. Examples are tillage practices that leave crop residue on the surface.

This soil is suited to tame pasture and hay. The shallow root zone and the low available water capacity, however, limit the choice of pasture plants and productivity. Crested wheatgrass is the best suited species.

This soil is suited to range. The native vegetation dominantly is needleandthread and blue grama. Overused areas are dominated by western wheatgrass, blue grama, and weeds.

This soil is poorly suited to windbreaks and environmental plantings because it is droughty and has a shallow root zone. Carefully selected trees and shrubs can be established, but optimum survival, growth, and vigor are unlikely.

The capability unit is IVs-1; Shallow to Gravel range site.

LeB—Lehr loam, 3 to 6 percent slopes. This somewhat excessively drained, gently sloping soil is on terraces and outwash plains. It is shallow over gravelly material. Areas are irregular in shape and 10 to 50 acres in size. Slopes are long and smooth.

Typically, the surface layer is dark gray loam about 5 inches thick. The subsoil is dark grayish brown, friable loam about 10 inches thick. The underlying material to a depth of 60 inches is grayish brown and light brownish gray, calcareous gravelly loamy sand. In places the subsoil contains more sand. In some areas the depth to gravelly material is less than 14 inches.

Included with this soil in mapping are small areas of the well drained Bowdle and Tally soils. These soils make up less than 10 percent of any one mapped area. Bowdle soils are 20 to 40 inches deep over gravelly material. They are in swales and on foot slopes. Tally soils contain more sand in the subsoil than the Lehr soil and do not have gravelly material within a depth of 40 inches. They are on slight rises.

Fertility is medium or low and organic matter content moderate in the Lehr soil. Tilth is good. Available water capacity is low. Permeability is moderately rapid in the subsoil and rapid in the gravelly underlying material. Runoff is slow. The porous underlying material restricts the development of plant roots.

About half of the acreage is cropland. This soil is suited to cultivated crops, but it is droughty because it is shallow to gravelly material. It is best suited to early maturing small grain. Measures that conserve moisture and control erosion are the main management needs. Examples are tillage practices that leave crop residue on the surface. Grassed waterways help to keep gullies from forming.

This soil is suited to tame pasture and hay. The shallow root zone and the low available water capacity, however, limit the choice of pasture plants and productivity. Crested wheatgrass is the best suited species.

This soil is suited to range. The native vegetation dominantly is needleandthread and blue grama. Overused areas are dominated by western wheatgrass, blue grama, and weeds.

This soil is suited to windbreaks and environmental plantings, but it is droughty because it has a shallow root zone. Carefully selected trees and shrubs can be established, but optimum survival, growth, and vigor are unlikely.

The capability unit is IVe-6; Shallow to Gravel range site.

MaA—Manning sandy loam, 0 to 3 percent slopes. This somewhat excessively drained, nearly level soil is on terraces. It is shallow or moderately deep over gravelly material. Areas are irregular in shape and 10 to 280 acres in size. Slopes are smooth or slightly convex.

Typically, the surface layer is dark grayish brown sandy loam about 7 inches thick. The subsoil is about 15 inches of dark brown and brown, very friable sandy loam and loamy sand. The underlying material to a depth of 60 inches is grayish brown and pale brown, calcareous gravelly loamy sand and gravelly sand.

Included with this soil in mapping are small areas of the well drained Bowdle and Tally soils. These soils make up less than 10 percent of any one mapped area. Bowdle soils contain more clay in the subsoil than the Manning soil. Also, they are lower on the landscape. Tally soils do not have gravel in the underlying material. They are on slight rises.

Fertility is low and organic matter content moderate in the Manning soil. Tilth is good. Available water capacity is low. Permeability is moderately rapid in the subsoil and very rapid in the underlying material. Runoff is slow.

Most of the acreage is cropland. This soil is suited to cultivated crops, but it is droughty. It is best suited to early maturing small grain. Productivity is limited by the shallow or moderately deep root zone and the low available water capacity. Measures that conserve moisture, control wind erosion, and improve fertility are the main management needs. Examples are leaving crop residue on the surface and including grasses and legumes in the cropping system.

A cover of tame pasture plants or hay is effective in controlling wind erosion. Only those grasses that are drought resistant are suitable. Crested wheatgrass and pubescent wheatgrass are examples.

This soil is suited to range. The native vegetation dominantly is prairie sandreed and needleandthread. Overused areas are dominated by needleandthread, blue grama, Kentucky bluegrass, and weeds.

This soil is suited to windbreaks and environmental plantings, but it is droughty because it has a shallow or moderately deep root zone. Carefully selected trees and shrubs can be established, but optimum survival, growth, and vigor are unlikely.

The capability unit is IIIe-9; Sandy range site.

MbA—Manning Variant loam, 0 to 3 percent slopes. This nearly level, somewhat poorly drained soil is on the edges of large upland depressions. It is very shallow to gravelly material, which is underlain by loamy glacial till. In many areas scattered stones are on the surface. Areas are 10 to 80 acres in size and generally are long and narrow.

Typically, the surface layer is very dark gray loam about 4 inches thick. The next 6 inches is grayish brown gravelly loamy sand. The upper 27 inches of the underlying material is gray and light brownish gray, mottled, calcareous gravelly loamy sand. The lower part to a depth of 60 inches is pale olive, mottled, calcareous clay loam. In some areas the glacial till is below a depth of 40 inches.

Included with this soil in mapping are small areas of the very poorly drained Parnell soils in the deeper parts of the depressions. These soils make up less than 10 percent of any one mapped area.

Fertility and organic matter content are low in the Manning Variant soil. Tilth is good. Available water capacity is low. Permeability is moderately rapid or rapid in the upper part of the soil and slow in the underlying glacial till. A seasonal high water table is at a depth of 2 to 4 feet during part of the growing season. Runoff is slow.

Most of the acreage supports native grasses and is used for grazing. This soil is suited to range. The native vegetation dominantly is needleandthread and blue grama. Overused areas are dominated by blue grama, sedges, and forbs.

This soil is suited to cultivated crops. It is droughty most of the growing season, however, because it is very shallow to gravelly loamy sand. Measures that conserve moisture are the main management needs. Examples are tillage practices that leave crop residue on the surface.

This soil is suited to tame pasture and hay. The low available water capacity and the shallow root zone, however, limit the choice of pasture plants. Crested wheatgrass is the best suited species.

Because it is droughty most of the growing season and has a shallow root zone, this soil is poorly suited to windbreaks and environmental plantings. Carefully selected trees and shrubs can be established, but optimum survival, growth, and vigor are unlikely.

The capability unit is IVs-1; Shallow to Gravel range site.

MdA—Max-Arnegard loams, 0 to 3 percent slopes. These deep, well drained, nearly level soils are on uplands. The Max soil is on the higher parts of the landscape. The Arnegard soil is in swales. It is occasionally flooded for very brief periods. Areas are irregular in shape and 7 to 400 acres in size. They are 60 to 70 percent Max soil and 20 to 30 percent Arnegard soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Max soil is dark grayish brown loam about 8 inches thick. The subsoil is brown and light yellowish brown, friable loam about 13 inches thick. It is calcareous in the lower part. The underlying material to a depth of 60 inches is light brownish gray and pale yellow, calcareous loam. It is mottled in the lower part. In some areas the subsoil contains more clay. In other areas it contains less sand and more silt.

Typically, the surface layer of the Arnegard soil is dark gray loam about 8 inches thick. The subsoil is dark grayish brown and brown, friable loam about 15 inches thick. The underlying material to a depth of 60 inches is light brownish gray, calcareous loam. It is mottled in the lower part.

Included with these soils in mapping are small areas of Niobell, Nishon, Noonan, and Tonka soils. These included soils make up less than 15 percent of any one mapped area. Niobell and Noonan soils have a sodium affected subsoil. They occur as areas intermingled with some areas of the Max soil. The poorly drained Nishon and Tonka soils are in depressions.

Fertility is medium and organic matter content moderate in the Max soil. Fertility and organic matter content are high in the Arnegard soil. Tilth is good in both soils. Available water capacity is high. Permeability is moderate in the subsoil of the Max soil and moderately slow in the underlying material. It is moderate in the Arnegard soil. The Arnegard soil has a seasonal high water table at a depth of 3 to 6 feet. Runoff is slow on both soils. The shrink-swell potential is moderate.

Most of the acreage is cropland. These soils are suited to cultivated crops and to alfalfa, intermediate wheatgrass, and smooth bromegrass for tame pasture and hay. Measures that conserve moisture are the main management needs. Leaving crop residue on the surface is an example. Planting and harvesting are delayed during some wet periods when the Arnegard soil receives runoff from adjacent soils.

These soils are suited to native grasses, but only a few areas are used for range. The native vegetation on the Max soil dominantly is western wheatgrass and needlegrasses. That on the Arnegard soil dominantly is big bluestem and lesser amounts of western wheatgrass and green needlegrass. Overused areas are dominated by needleandthread, blue grama, and Kentucky bluegrass.

These soils are suited to windbreaks and environmental plantings. All climatically suited trees and shrubs grow well on the Max soil. Those that require an abundant supply of moisture grow especially well on the Arnegard soil.

The Max soil is in capability unit IIc-2, Silty range site; the Arnegard soil in capability unit IIc-3, Overflow range site.

MmB—Max-Arnegard-Zahl loams, 1 to 6 percent slopes. These deep, well drained, nearly level and undulating soils are on uplands. The Max soil is on the mid and upper side slopes. The Arnegard soil is in swales. It is occasionally flooded for very brief periods. The Zahl soil is on the upper side slopes and on knolls. In some convex areas scattered stones are on the surface. Areas are irregular in shape and 10 to 1,000 acres in size. They are 40 to 50 percent Max soil, 20 to 30 percent Arnegard soil, and 15 to 25 percent Zahl soil. The three soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Max soil is dark grayish brown loam about 8 inches thick. The subsoil is brown and light yellowish brown, friable loam about 13 inches thick. It is calcareous in the lower part. The underlying material to a depth of 60 inches is light brownish gray and pale yellow, calcareous loam. It is mottled in the lower part. In places the subsoil contains more silt and less sand.

Typically, the surface layer of the Arnegard soil is dark gray loam about 8 inches thick. The subsoil is dark grayish brown and brown, friable loam about 15 inches thick. The underlying material to a depth of 60 inches is light brownish gray, calcareous loam. It is mottled in the lower part.

Typically, the surface layer of the Zahl soil is grayish brown, calcareous loam about 6 inches thick. The underlying material to a depth of 60 inches is grayish brown, light brownish gray, and pale yellow, calcareous loam. It is mottled in the lower part.

Included with these soils in mapping are small areas of Niobell, Noonan, Tally, and Tonka soils. These included soils make up less than 15 percent of any one mapped area. Niobell and Noonan soils have a sodium affected subsoil. They are on the lower side slopes. Tally soils contain less clay in the subsoil than the Arnegard, Max, and Zahl soils. They are in a random pattern throughout the mapped areas. The poorly drained Tonka soils are in depressions.

Fertility is medium in the Max soil, high in the Arnegard soil, and low in the Zahl soil. Organic matter content is moderate in the Max soil, high in the Arnegard soil, and low in the Zahl soil. Tilth is good in all three soils. Available water capacity is high. Permeability is moderate in the subsoil of the Max and Zahl soils and moderately slow in the underlying material. It is moderate in the Arnegard soil. The Arnegard soil has a seasonal high water table at a depth of 3 to 6 feet. Runoff is medium on all three soils. The shrink-swell potential is moderate.

Most of the acreage is cropland. These soils are suited to cultivated crops. Measures that control erosion are the main management needs. Measures that improve fertility also are needed on the Zahl soil because the high content of lime in the surface layer adversely affects the availability of plant nutrients. Leaving crop residue on the surface and including grasses and legumes in the cropping system help to control erosion and improve fertility. Contour farming and terraces also can help to control erosion, but in some areas the slopes are too short or too irregular for contouring and terracing. Grassed waterways help to keep gullies from forming.

A cover of tame pasture plants or hay is effective in controlling erosion. These soils are suited to tame pasture and hay, but production is limited on the Zahl soil because the high content of lime in the surface layer adversely affects the availability of plant nutrients.

Alfalfa, intermediate wheatgrass, and smooth bromegrass are the best suited species.

These soils are suited to range. The native vegetation on the Max soil dominantly is needlegrasses and western wheatgrass, that on the Arnegard soil is green needlegrass and big bluestem, and that on the Zahl soil is little bluestem, needlegrasses, western wheatgrass, and sideoats grama. Overused areas are dominated by needleandthread, Kentucky bluegrass, blue grama, and weeds.

These soils are suited to windbreaks and environmental plantings, but the high content of lime in the surface layer of the Zahl soil adversely affects the availability of plant nutrients. Except for those species that require an abundant supply of moisture, all climatically suited trees and shrubs grow well on the Max soil. Those that require an abundant moisture supply grow especially well on the Arnegard soil. No trees or shrubs grow well on the Zahl soil; optimum survival, growth, and vigor are unlikely.

The Max soil is in capability unit IIe-2, Silty range site; the Arnegard soil is in capability unit IIe-3, Overflow range site; the Zahl soil is in capability unit IVe-2, Thin Upland range site.

MnB—Max-Niobell-Noonan loams, 2 to 6 percent slopes. These deep, nearly level and undulating soils are on uplands. The well drained Max soil is on knolls and the mid and upper side slopes. The moderately well drained Niobell and Noonan soils are on the lower side slopes and in shallow swales. Scattered stones are on the surface in some areas of the Max soil. Areas are 10 to more than 700 acres in size and irregular in shape. They are 45 to 55 percent Max soil, 15 to 25 percent Niobell soil, and 10 to 20 percent Noonan soil. The three soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Max soil is dark grayish brown loam about 8 inches thick. The subsoil is brown and light yellowish brown, friable loam about 13 inches thick. It is calcareous in the lower part. The underlying material to a depth of 60 inches is light brownish gray and pale yellow, calcareous loam. It is mottled in the lower part. In some areas the subsoil contains more clay.

Typically, the surface layer of the Niobell soil is dark grayish brown loam about 7 inches thick. The subsoil is about 19 inches thick. The upper part is grayish brown loam, and the lower part is dark grayish brown and brown, firm clay loam. The underlying material to a depth of 60 inches is grayish brown and light brownish gray, calcareous loam. It is mottled in the lower part.

Typically, the surface layer of the Noonan soil is grayish brown loam about 6 inches thick. The subsurface layer is light brownish gray loam about 2 inches thick. The subsoil is about 15 inches of brown and light yellowish brown, very firm, firm, and friable clay loam and loam. The underlying material to a depth of 60 inches is light gray and pale yellow, calcareous loam.

Included with these soils in mapping are small areas of Arnegard, Heil, Miranda, Nishon, Tonka, and Zahl soils. These included soils make up less than 20 percent of any one mapped area. The well drained Arnegard soils are in swales. They do not have a sodium affected subsoil. The poorly drained Heil, Nishon, and Tonka soils are in depressions. Miranda soils have a thin surface layer and have visible salts within a depth of 16 inches. They are in small pits and depressions. Zahl soils have lime at or near the surface. They are on knolls.

Fertility is medium and organic matter content moderate in the Max, Niobell, and Noonan soils. The Niobell and Noonan soils have a sodium affected subsoil that restricts root penetration. Tilth is good in the Max and Niobell soils and poor in the Noonan soil. Available water capacity is high in the Max soil, moderate or high in the Niobell soil, and moderate in the Noonan soil. Permeability is moderate in the subsoil of the Max soil and moderately slow in the underlying material. It is slow in the Niobell and Noonan soils. Runoff is medium on all three soils. The shrink-swell potential is moderate in the Max soil and high in the subsoil of the Niobell and Noonan soils.

About half of the acreage supports native grasses and is used for grazing. These soils are suited to range. The native vegetation on the Max soil dominantly is needlegrasses and western wheatgrass. That on the Niobell and Noonan soils dominantly is western wheatgrass and blue grama. Overused areas are dominated by western wheatgrass, needleandthread, and blue grama. If overuse continues, blue grama, buffalograss, and weeds occupy the site.

This map unit is suited to cultivated crops, but the claypan subsoil in the Niobell and Noonan soils restricts the penetration of plant roots. Measures that conserve moisture, control erosion, increase the rate of water intake, and improve tilth are the main management needs. Examples are leaving crop residue on the surface and including grasses and legumes in the cropping system. Other measures that improve tilth and increase the rate of water intake are timely tillage and chiseling or subsoiling.

These soils are suited to tame pasture and hay, but the dense, compact subsoil in the Noonan soil limits the choice of pasture plants and productivity. Alfalfa, intermediate wheatgrass, and pubescent wheatgrass are suitable.

These soils are suited to windbreaks and environmental plantings, but the dense subsoil in the Noonan soil severely limits root penetration. The only climatically suited trees and shrubs that do not grow well on the Max and Niobell soils are those that require an abundant supply of moisture. Windbreaks and environmental plantings can be established on the

Noonan soil, but optimum survival, growth, and vigor are unlikely.

The Max soil is in capability unit IIe-2, Silty range site; the Niobell soil is in capability unit IIIe-3, Clayey range site; the Noonan soil is in capability unit IVs-3, Claypan range site.

MoA—Mondamin silty clay loam, 0 to 2 percent slopes. This deep, moderately well drained, nearly level soil is on uplands. Areas are 5 to 200 acres in size and irregular in shape. Slopes are smooth or slightly convex.

Typically, the surface layer is dark grayish brown silty clay loam about 6 inches thick. The subsoil is grayish brown and light brownish gray, firm silty clay about 21 inches thick. It is calcareous in the lower part. The underlying material to a depth of 60 inches is light brownish gray, mottled, calcareous silty clay loam. In some areas the surface layer and subsoil contain more sand. In places loamy glacial till is within a depth of 40 inches.

Included with this soil in mapping are small areas of Bryant, Cavo, Nishon, and Williams soils. These soils make up less than 15 percent of any one mapped area. The well drained Bryant and Williams soils are in positions on the landscape similar to those of the Mondamin soil. Bryant soils contain less clay in the subsoil than the Mondamin soil, and the loamy Williams soils contain more sand and less clay throughout. Cavo soils have a sodium affected subsoil. They are in small pits and depressions. The poorly drained Nishon soils are in depressions.

Fertility is medium and organic matter content moderate in the Mondamin soil. Tilth is fair. Available water capacity is high. Permeability is moderately slow or slow. A water table is at a depth of 5 to 6 feet during wet periods. Runoff is slow. The shrink-swell potential is high in the subsoil.

Most of the acreage is cropland. This soil is suited to cultivated crops and to alfalfa, intermediate wheatgrass, and smooth bromegrass for tame pasture and hay. Measures that conserve moisture and improve tilth are the main management needs. An example is leaving crop residue on the surface. Other measures that improve tilth are timely tillage and chiseling or subsoiling.

This soil is suited to native grasses, but only a few areas are used for range. The native vegetation dominantly is western wheatgrass and green needlegrass. Overused areas are dominated by western wheatgrass and short grasses.

This soil is suited to windbreaks and environmental plantings. It takes in water slowly, however, and the clayey subsoil can restrict the penetration of plant roots.

The capability unit is IIs-1; Clayey range site.

MoB—Mondamin silty clay loam, 2 to 6 percent slopes. This deep, well drained, gently sloping soil is on uplands. Areas are 5 to 110 acres in size and irregular in shape. Slopes generally are long and slightly convex.

Typically, the surface layer is dark grayish brown silty clay loam about 6 inches thick. The subsoil is grayish brown and light brownish gray, firm silty clay about 21 inches thick. It is calcareous in the lower part. The underlying material to a depth of 60 inches is light brownish gray, mottled, calcareous silty clay loam. In some areas the surface layer and subsoil contain more sand. In places loamy glacial till is within a depth of 40 inches.

Included with this soil in mapping are small areas of Bryant, Cavo, Nishon, and Williams soils. These soils make up less than 15 percent of any one mapped area. Bryant and Williams soils are in positions on the landscape similar to those of the Mondamin soil. Bryant soils contain less clay in the subsoil than the Mondamin soil, and the loamy Williams soils contain more sand and less clay throughout. The moderately well drained Cavo soils have a sodium affected subsoil. They are on low side slopes. The poorly drained Nishon soils are in depressions.

Fertility is medium and organic matter content moderate in the Mondamin soil. Tilth is fair. Available water capacity is high. Permeability is moderately slow or slow. A water table is at a depth of 5 to 6 feet during wet periods. Runoff is medium. The shrink-swell potential is high in the subsoil.

Most of the acreage is cropland. This soil is well suited to cultivated crops and to alfalfa, intermediate wheatgrass, and smooth bromegrass for tame pasture and hay. Measures that conserve moisture, improve tilth, and control erosion are the main management needs. Examples are leaving crop residue on the surface and including grasses and legumes in the cropping system. Other measures that improve tilth are timely tillage and chiseling or subsoiling.

This soil is suited to native grasses, but only a few areas are used for range. The native vegetation dominantly is western wheatgrass and green needlegrass. Overused areas are dominated by western wheatgrass and short grasses.

This soil is suited to windbreaks and enviornmental plantings. It takes in water slowly, however, and the clayey subsoil can restrict the penetration of plant roots.

The capability unit is IIIe-3; Clayey range site.

NaA—Niobell-Noonan loams, 0 to 3 percent slopes. These deep, moderately well drained, nearly level soils are on uplands. The Niobell soil is on the higher parts of the landscape, and the Noonan soil is on the lower parts. The surface is uneven because of many scattered low spots. In some areas a few scattered stones are on the surface. Areas are irregular in shape and 5 to 200 acres in size. They are 35 to 45 percent Niobell soil and 25 to 35 percent Noonan soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Niobell soil is dark grayish brown loam about 7 inches thick. The subsurface layer is about 5 inches of grayish brown and gray loam and silt loam. The subsoil is dark grayish brown and brown, firm clay loam about 14 inches thick. The underlying material to a depth of 60 inches is grayish brown and light brownish gray, calcareous loam. It is mottled in the lower part.

Typically, the surface layer of the Noonan soil is grayish brown loam about 6 inches thick. The subsurface layer is light brownish gray loam about 2 inches thick. The subsoil is about 15 inches of brown and light yellowish brown, very firm, firm, and friable clay loam and loam. The underlying material to a depth of 60 inches is light gray and pale yellow, calcareous loam.

Included with these soils in mapping are small areas of Bowbells, Nishon, Tonka, and Williams soils. These included soils make up less than 30 percent of any one mapped area. Bowbells soils do not have a sodium affected subsoil. They are in swales. The poorly drained Nishon and Tonka soils are in depressions. The well drained Williams soils are on slight rises. They do not have a sodium affected subsoil.

Fertility is medium and organic matter content moderate in the Niobell and Noonan soils. Both soils have a sodium affected subsoil that restricts root penetration. Tilth is good in the Niobell soil and poor in the Noonan soil. Available water capacity is moderate or high in the Niobell soil and moderate in the Noonan soil. Permeability is slow in both soils. Runoff also is slow. The shrink-swell potential is high in the subsoil and moderate in the underlying material.

Most of the acreage supports native grasses and is used for grazing. These soils are suited to range. The native vegetation dominantly is western wheatgrass, green needlegrass, and blue grama. Overused areas are dominated by western wheatgrass and blue grama. If overuse continues, buffalograss, blue grama, and weeds dominate the site.

These soils are suited to cultivated crops, but the claypan subsoil restricts the penetration of plant roots. The soils are better suited to small grain and to alfalfa, intermediate wheatgrass, and pubescent wheatgrass for tame pasture and hay than to row crops. Measures that increase the rate of water intake, conserve moisture, and improve tilth are the main management needs. Examples are leaving crop residue on the surface and including grasses and legumes in the cropping system. Other measures that improve tilth and increase the rate of water intake are timely tillage and chiseling or subsoiling.

These soils are suited to windbreaks and environmental plantings, but the sodium affected subsoil severely restricts tree growth. Carefully selected trees and shrubs can be established, but optimum growth, survival, and vigor are unlikely.

The Niobell soil is in capability unit IIIs-1, Clayey range site; the Noonan soil is in capability unit IVs-2, Claypan range site.

NbA—Niobell-Noonan-Max loams, 0 to 3 percent slopes. These deep, nearly level soils are on uplands. The moderately well drained Niobell and Noonan soils are on the lower side slopes and in swales. The well drained Max soil is on the higher parts of the landscape. In some areas scattered stones are on the surface. Areas are 5 to 100 acres in size and irregular in shape. They are 25 to 35 percent Niobell soil, 20 to 30 percent Noonan soil, and 20 to 30 percent Max soil. The three soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Niobell soil is dark grayish brown loam about 7 inches thick. The subsurface layer is about 5 inches of grayish brown and gray loam and silt loam. The subsoil is dark grayish brown and brown, firm clay loam about 14 inches thick. The underlying material to a depth of 60 inches is grayish brown and light brownish gray, calcareous loam. It is mottled in the lower part.

Typically, the surface layer of the Noonan soil is grayish brown loam about 6 inches thick. The subsurface layer is light brownish gray loam about 2 inches thick. The subsoil is about 15 inches of brown and light yellowish brown, very firm, firm, and friable clay loam and loam. The underlying material to a depth of 60 inches is light gray and pale yellow, calcareous loam.

Typically, the surface layer of the Max soil is dark grayish brown loam about 8 inches thick. The subsoil is brown and light yellowish brown, friable loam about 13 inches thick. It is calcareous in the lower part. The underlying material to a depth of 60 inches is light brownish gray and pale yellow, calcareous loam. It is mottled in the lower part. In places the subsoil contains more silt and less sand.

Included with these soils in mapping are small areas of Arnegard, Heil, Miranda, Nishon, and Tonka soils. These included soils make up less than 20 percent of any one mapped area. The well drained Arnegard soils are in swales. They do not have a sodium affected subsoil. The poorly drained Heil, Nishon, and Tonka soils are in depressions. The somewhat poorly drained Miranda soils are in small pits and depressions. They have visible salts within a depth of 16 inches.

Fertility is medium and organic matter content moderate in the Niobell, Noonan, and Max soils. The Niobell and Noonan soils have a sodium affected subsoil that restricts root penetration. Tilth is poor in the Noonan soil and good in the Niobell and Max soils. Available water capacity is moderate or high in the Niobell soil, moderate in the Noonan soil, and high in the Max soil. Permeability is slow in the Niobell and Noonan soils. It is moderate in the subsoil of the Max soil and moderately slow in the underlying material. Runoff is slow on all three soils. The shrink-swell potential is high in the subsoil of the Niobell and Noonan soils and moderate in the Max soil.

Most of the acreage supports native grasses and is used for grazing. These soils are suited to range. The native vegetation on the Niobell and Noonan soils dominantly is western wheatgrass and green needlegrass. That on the Max soil dominantly is green needlegrass, western wheatgrass, and needleandthread. Overused areas are dominated by western wheatgrass and needleandthread. If overuse continues, blue grama, buffalograss, and weeds dominate the site.

These soils are suited to cultivated crops. The claypan subsoil in the Niobell and Noonan soils, however, restricts the penetration of plant roots. Measures that conserve moisture, increase the rate of water intake, and improve tilth are the main management needs. Examples are leaving crop residue on the surface and including grasses and legumes in the cropping system. Other measures that improve tilth and increase the rate of water intake are timely tillage and chiseling or subsoiling.

These soils are suited to tame pasture and hay, but the dense, compact subsoil in the Noonan soil limits the choice of pasture plants and productivity. Alfalfa, intermediate wheatgrass, and pubescent wheatgrass are suitable pasture plants.

These soils are suited to windbreaks and environmental plantings. No trees or shrubs grow well on the Noonan soil, however, because the dense subsoil severely limits root penetration. Windbreaks and environmental plantings can be established on this soil, but optimum survival, growth, and vigor are unlikely.

The Niobell soil is in capability unit IIIs-1, Clayey range site; the Noonan soil is in capability unit IVs-2, Claypan range site; the Max soil is in capability unit IIc-2, Silty range site.

Nn—Nishon silt loam. This deep, poorly drained, level soil is in shallow depressions in the uplands. It is ponded for long periods during spring runoff and after heavy rainfall. Areas are oval or oblong and are 3 to 40 acres in size. Slopes are concave.

Typically, the surface layer is dark gray silt loam about 2 inches thick. The subsurface layer is light gray, mottled silt loam about 5 inches thick. The subsoil is dark gray, very firm silty clay about 25 inches thick. The underlying material to a depth of 60 inches is light olive gray, mottled, calcareous silty clay loam. In places the surface soil is less than 5 inches thick.

Included with this soil in mapping are small areas of the very poorly drained Parnell soils in the deeper parts of the depressions. These soils make up less than 10 percent of any one mapped area. Their surface layer is darker than that of the Nishon soil.

Fertility and organic matter content are low in the Nishon soil. Tilth is poor. Available water capacity is moderate or high. Permeability is slow. A seasonal high water table is within a depth of 1.0 foot most of the year. As much as 0.5 foot of water ponds on the surface during some wet periods. Runoff is ponded. The shrink-swell potential is high.

Most of the acreage supports native grasses and is used for grazing. This soil is suited to range. The native vegetation dominantly is western wheatgrass. Overused areas are dominated by buffalograss, Kentucky bluegrass, saltgrass, sedges, and weeds. Many areas are potential sites for excavated ponds.

This soil is suited to cultivated crops if it is drained. Suitable drainage outlets, however, generally are not available. Crops commonly drown out. Fieldwork usually is delayed for long periods because of the wetness. The best suited crops are those that mature late in the growing season.

This soil is suited to tame pasture and hay, but only the water tolerant pasture plants grow well in the undrained areas. Garrison creeping foxtail and reed canarygrass are the best suited species.

This soil generally is unsuited to windbreaks and environmental plantings unless it is drained. The trees and shrubs that require an abundant supply of moisture grow well in drained areas.

The capability unit is IVw-1; Closed Depression range site.

NoA—Noonan-Miranda loams, 0 to 5 percent slopes. These deep, nearly level and undulating soils are on uplands. The moderately well drained Noonan soil is on slight rises. The somewhat poorly drained Miranda soil is in small pits and depressions. Areas are 10 to 700 acres in size and irregular in shape. They are 40 to 50 percent Noonan soil and 25 to 35 percent Miranda soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Noonan soil is grayish brown loam about 6 inches thick. The subsurface layer is light brownish gray loam about 2 inches thick. The subsoil is about 15 inches of brown and light yellowish brown, very firm, firm, and friable clay loam and loam. The underlying material to a depth of 60 inches is light gray and pale yellow, calcareous loam. In some areas the subsoil does not have columnar structure.

Typically, the surface layer of the Miranda soil is dark gray loam about 3 inches thick. The subsurface layer is gray loam about 2 inches thick. The subsoil is dark grayish brown and grayish brown, firm and very firm clay loam. It has visible salt crystals in the lower part. The underlying material to a depth of 60 inches is light olive brown and pale olive, calcareous clay loam.

Included with these soils in mapping are small areas of Arnegard, Max, Nishon, Tonka, and Williams soils. These included soils make up less than 20 percent of any one mapped area. The well drained Arnegard, Max, and Williams soils do not have a sodium affected subsoil. Arnegard soils are in swales, and Max and Williams soils are on knolls and slight rises. The poorly drained Nishon and Tonka soils are in depressions.

Fertility is medium in the Noonan soil and low in the Miranda soil. Organic matter content is moderate in both soils. Tilth is poor. Available water capacity is moderate. Permeability is slow in the Noonan soil and very slow in the Miranda soil. Runoff is slow on both soils. The shrink-swell potential is high in the subsoil of the Noonan soil and moderate in the underlying material. It is moderate in the Miranda soil.

Most of the acreage supports native grasses and is used for grazing. These soils are suited to range. Productivity is limited in areas of the Miranda soil, however, because the dense claypan subsoil restricts the penetration of plant roots. The native vegetation dominantly is western wheatgrass, green needlegrass, blue grama, and pricklypear. Overused areas are dominated by blue grama, buffalograss, saltgrass, and pricklypear.

These soils are suited to cultivated crops. The dense claypan subsoil and the high content of sodium, however, adversely affect crop growth by restricting root penetration and the rate of water intake. Tilling is difficult because the dense subsoil is near the surface. If the soils are cultivated when wet, they become cloddy. Leaving crop residue on the surface and including grasses and legumes in the cropping system improve tilth and fertility, increase the rate of water intake, and conserve moisture.

The Noonan soil is suited to alfalfa, crested wheatgrass, intermediate wheatgrass, and pubescent wheatgrass for tame pasture and hay. No grass species grow well, however, on the Miranda soil.

The Noonan soil is suited to windbreaks and environmental plantings, but the Miranda soil generally is unsuited. Carefully selected trees and shrubs can be established on the Noonan soil, but optimum survival, growth, and vigor are unlikely. No trees and shrubs grow well on the Miranda soil.

The Noonan soil is in capability unit IVs-2, Claypan range site; the Miranda soil is in capability unit VIs-1, Thin Claypan range site.

Pa—Parnell silty clay loam. This deep, very poorly drained, level soil is in upland depressions. It is ponded for short periods. Areas are circular or oblong and are 3 to 285 acres in size. Slopes are concave.

Typically, the surface layer is dark gray silty clay loam about 6 inches thick. The subsoil is dark gray, very firm silty clay about 44 inches thick. The underlying material to a depth of 60 inches is gray, mottled clay loam. In some areas the surface layer is clay loam. In other areas it is thicker.

Included with this soil in mapping are small areas of the poorly drained Heil soils near the edges of the depressions. These soils make up less than 10 percent of any one mapped area.

Fertility and organic matter content are high in the Parnell soil. Available water capacity is moderate or high. Permeability is slow. A seasonal high water table is within a depth of 2 feet most of the year. As much as 2 feet of water ponds on the surface during some wet periods. Runoff is ponded. The shrink-swell potential is high.

Most of the acreage supports native grasses and is used as range or as habitat for wildlife. A few small areas are cultivated along with the adjacent soils. This soil is suited to range. The native vegetation dominantly is rivergrass and slough sedge. Overused areas are dominated by saltgrass, sedges, and rushes. Many areas are potential sites for excavated ponds.

This soil generally is unsuited to cultivated crops and to windbreaks and environmental plantings because of the ponding. It is suited to tame pasture and hay. Because the soil generally cannot be drained, however, the choice of pasture plants is limited to water tolerant grasses, such as Garrison creeping foxtail and reed canarygrass.

This soil is suited to wetland wildlife habitat. Wetland plants, such as rivergrass, slough sedge, and American bulrush, are dominant in ungrazed areas. Level ditches or shallow pits provide areas of open water that enhance the habitat for wetland wildlife.

The capability unit is Vw-4; Shallow Marsh range site.

Pp—Parnell silty clay loam, ponded. This deep, very poorly drained, level soil is in depressions in the uplands. In most years it is ponded by water that is seldom more than 2 feet deep during the growing season. Areas are circular or oblong and are 3 to 160 acres in size.

Typically, the surface layer is dark gray silty clay loam about 6 inches thick. The subsoil is dark gray, very firm silty clay about 44 inches thick. The underlying material to a depth of 60 inches is gray, mottled clay loam. In some areas the surface layer is calcareous.

Included with this soil in mapping are small areas of the poorly drained Heil soils at the edges of the depressions. These soils make up less than 10 percent of any one mapped area.

Fertility and organic matter content are high in the Parnell soil. Available water capacity is moderate or high. Permeability is slow. A seasonal high water table is within a depth of 2 feet. As much as 2 feet of water ponds on the surface during some wet periods. The shrink-swell potential is high.

In most areas this soil is used as wetland wildlife habitat (fig. 6). It is suited to this use. Deer, pheasants, and other wildlife frequent the margins of these areas. The native vegetation, which is cattails, rushes, and sedges, provides food and cover for a variety of waterfowl and wetland birds. Ducks nest on the drier adjacent sites and raise their broods in the ponded areas. Geese and other waterfowl use these areas as periodic resting and feeding sites during migration. The

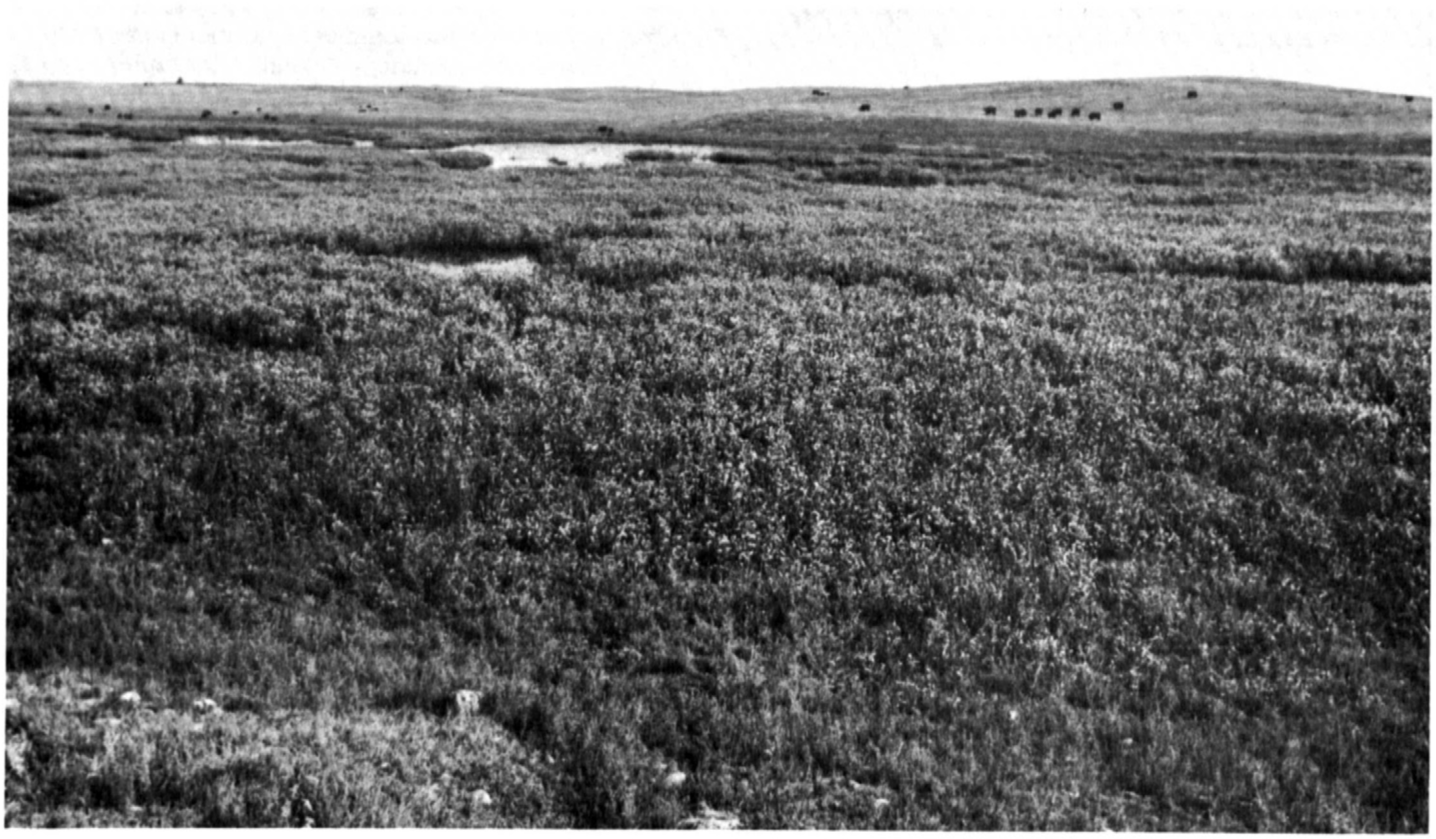

Figure 6.—An area of Parnell silty clay loam, ponded, used as habitat for wetland wildlife. The cattle in the background are on Williams soils.

vegetated areas commonly are interspersed with small bodies of open water.

Because it is wet, this soil generally is unsuitable for cultivated crops, range, tame pasture and hay, and windbreaks and environmental plantings.

The capability unit is VIIIw-1; no range site is assigned.

Pt—Pits, gravel. These areas are open excavations, 5 to 30 feet deep, from which sand and gravel are being removed. They are irregular in shape and 2 to 30 acres in size. Slopes are uneven and broken. They range from nearly level on the pit bottoms to almost vertical on the rims. Some of the pit bottoms are covered with water.

The pit bottoms typically are sand and gravel, but they are loam or clay loam glacial till or silty glacial till in areas where all of the sand and gravel has been removed. Mounds of mixed cobbly, stony, and loamy overburden are on the edges of the areas. The bottoms and sides support little or no vegetation during periods when the pits are used.

Most gravel pits can be used only as a source of sand and gravel for construction purposes. Some provide limited wildlife habitat. Abandoned gravel pits can be restored to range, tame pasture, or cropland if reclamation measures are applied. These measures include shaping the areas and using the mounds of overburden material as topsoil dressing. Applying fertilizer as needed helps to establish range or pasture plants.

The capability unit is VIIIs-2; no range site is assigned.

RaA—Raber-Cavo complex, 0 to 2 percent slopes. These deep, nearly level soils are on uplands. The well drained Raber soil is on slight rises. The moderately well drained Cavo soil is in slight depressions. In some areas scattered stones are on the surface. Areas are irregular in shape and 10 to 140 acres in size. They are 55 to 65 percent Raber soil and 30 to 40 percent Cavo soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Raber soil is dark gray clay loam about 5 inches thick. The subsoil is grayish brown and light brownish gray, firm clay loam about 27 inches thick. It is calcareous in the lower part. The underlying material to a depth of 60 inches is light gray, mottled, calcareous clay loam. In some areas the subsoil contains less sand.

Typically, the surface layer of the Cavo soil is gray loam about 3 inches thick. The subsurface layer is gray loam about 2 inches thick. The subsoil is grayish brown and dark grayish brown, firm clay about 18 inches thick. It is calcareous in the lower part. The underlying material to a depth of 60 inches is light brownish gray and light gray, mottled, calcareous clay loam. In some areas the the subsoil does not have columnar structure.

Included with these soils in mapping are small areas of Heil, Miranda, Nishon, and Tonka soils. These included soils make up less than 15 percent of any one mapped area. The poorly drained Heil, Nishon, and Tonka soils are in depressions. Miranda soils are in small pits and depressions. They have visible salts within a depth of 16 inches. Their surface layer commonly is thinner than that of the Cavo soil.

Fertility is medium and organic matter content moderate in the Raber and Cavo soils. The Cavo soil has a sodium affected subsoil that restricts root penetration. Tilth is fair in the Raber soil and poor in the Cavo soil. Available water capacity is high in the Raber soil and moderate in the Cavo soil. Permeability is moderately slow or slow in the Raber soil. It is very slow in the subsoil of the Cavo soil and slow in the underlying material. Runoff is slow on both soils. The shrink-swell potential is high.

Most of the acreage supports native grasses and is used for grazing. These soils are suited to range. The native vegetation dominantly is western wheatgrass, blue grama, and green needlegrass. Overused areas are dominated by western wheatgrass. If overuse continues, buffalograss, blue grama, and weeds dominate the site.

These soils are suited to cultivated crops. The dense claypan subsoil and high content of sodium in the Cavo soil, however, adversely affect crop growth by restricting root penetration and the rate of water intake. Measures that conserve moisture and improve tilth are the main management needs. Examples are leaving crop residue on the surface and including grasses and legumes in the cropping system. Other measures that improve tilth are timely tillage and chiseling or subsoiling.

These soils are suited to tame pasture and hay, but the choice of pasture plants is limited by the sodium affected subsoil in the Cavo soil. Examples of suitable plants are alfalfa, pubescent wheatgrass, and intermediate wheatgrass.

These soils are suited to windbreaks and environmental plantings, but the sodium affected subsoil in the Cavo soil restricts root development. Windbreaks and environmental plantings can be established on this soil, but optimum survival, growth, and vigor are unlikely.

The Raber soil is in capability unit IIc-2, Clayey range site; the Cavo soil is in capability unit IVs-2, Claypan range site.

RaB—Raber-Cavo complex, 2 to 6 percent slopes. These deep, nearly level and gently sloping soils are on uplands. The well drained Raber soil is on the higher parts of the landscape. The moderately well drained Cavo soil is on the mid and lower side slopes. In some areas scattered stones are on the surface. Areas are irregular in shape and 10 to 110 acres in size. They are 55 to 65 percent Raber soil and 25 to 35 percent Cavo soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Raber soil is dark gray clay loam about 5 inches thick. The subsoil is grayish brown and light brownish gray, firm clay loam about 27 inches thick. It is calcareous in the lower part. The underlying material to a depth of 60 inches is light gray, mottled, calcareous clay loam. In some areas the subsoil contains less sand.

Typically, the surface layer of the Cavo soil is gray loam about 3 inches thick. The subsurface layer is gray loam about 2 inches thick. The subsoil is grayish brown and dark grayish brown, firm clay about 18 inches thick. It is calcareous in the lower part. The underlying material to a depth of 60 inches is light brownish gray and light gray, mottled, calcareous clay loam. In some areas the subsoil does not have columnar structure.

Included with these soils in mapping are small areas of Heil, Miranda, Nishon, and Tonka soils. These included soils make up less than 15 percent of any one mapped area. The poorly drained Heil, Nishon, and Tonka soils are in depressions. Miranda soils are in small pits and depressions. They have visible salts within a depth of 16 inches. Their surface layer commonly is thinner than that of the Cavo soil.

Fertility is medium and organic matter content moderate in the Raber and Cavo soils. The Cavo soil has a sodium affected subsoil that restricts root penetration. Tilth is fair in the Raber soil and poor in the Cavo soil. Available water capacity is high in the Raber soil and moderate in the Cavo soil. Permeability is moderately slow or slow in the Raber soil. It is very slow in the subsoil of the Cavo soil and slow in the underlying material. Runoff is medium on both soils. The shrink-swell potential is high.

Most of the acreage supports native grasses and is used for grazing. These soils are suited to range. The native vegetation dominantly is western wheatgrass, blue grama, and green needlegrass. Overused areas are dominated by western wheatgrass. If overuse continues, buffalograss, blue grama, and weeds dominate the site.

These soils are suited to cultivated crops. The dense claypan subsoil and high content of sodium in the Cavo soil, however, adversely affect crop growth by restricting root penetration and the rate of water intake. Measures that conserve moisture, control erosion, and improve tilth are the main management needs. Examples are leaving crop residue on the surface and including grasses and legumes in the cropping system. Other measures that improve tilth are timely tillage and chiseling or subsoiling.

These soils are suited to tame pasture and hay, but the choice of pasture plants is limited by the sodium affected subsoil in the Cavo soil. Examples of suitable plants are alfalfa, pubescent wheatgrass, and intermediate wheatgrass.

These soils are suited to windbreaks and environmental plantings, but the sodium affected subsoil in the Cavo soil restricts root development. Windbreaks and environmental plantings can be established on this soil, but optimum survival, growth, and vigor are unlikely.

The Raber soil is in capability unit IIe-2, Clayey range site; the Cavo soil is in capability unit IVs-2, Claypan range site.

Rh—Ranslo-Harriet silt loams. These deep, nearly level soils are on flood plains that are occasionally flooded. A meandering stream channel dissects many areas. The somewhat poorly drained Ranslo soil is on slight rises. The poorly drained Harriet soil is in slight depressions and the lower areas near the channels. Areas are long and narrow and are 10 to 360 acres in size. They are 45 to 55 percent Ranslo soil and 35 to 45 percent Harriet soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Ranslo soil is dark gray silt loam about 6 inches thick. The subsurface layer is gray silt loam about 4 inches thick. The subsoil is about 21 inches of very dark gray, dark gray, and gray, firm silty clay and silty clay loam. It is calcareous in the lower part. The underlying material to a depth of 60 inches is gray, firm, calcareous silty clay loam.

Typically, the surface layer of the Harriet soil is gray silt loam about 3 inches thick. The subsoil is dark gray and gray, very firm silty clay about 8 inches thick. The underlying material to a depth of 60 inches is olive gray and pale olive, calcareous silty clay and silty clay loam. It has spots and nests of salts in the upper part.

Included with these soils in mapping are small areas of the moderately well drained La Prairie soils. These included soils make up less than 15 percent of any one mapped area. They do not have a sodium affected subsoil. They are higher on the flood plains than the Ranslo and Harriet soils.

Fertility is medium in the Ranslo soil and low in the Harriet soil. Organic matter content is high in the Ranslo soil and moderate in the Harriet soil. The dense, compact subsoil in both soils restricts root growth. Available water capacity is moderate or high in the Ranslo soil and moderate in the Harriet soil. Permeability is slow in the Ranslo soil and very slow in the Harriet soil. The Ranslo soil has a seasonal high water table at a depth of 1 to 3 feet, and the Harriet soil has one within a depth of 1 foot. Runoff is slow on both soils. The shrink-swell potential is high.

Most of the acreage supports native grasses and is used for grazing. These soils are better suited to range than to cropland. The native vegetation on the Ranslo soil dominantly is big bluestem, switchgrass, and western wheatgrass. That on the Harriet soil dominantly is western wheatgrass and saltgrass. Overused areas of the Ranslo soil are dominated by western wheatgrass, saltgrass, and Kentucky bluegrass. Saltgrass, foxtail barley, and weeds dominate overused areas of the Harriet soil. Grazing during wet periods causes compaction of the surface layer, which results in an increase in the extent of the less desirable grasses and of weeds. Many areas of the Ranslo soil are potential sites for excavated ponds.

These soils are suited to tame pasture and hay (fig. 7). Production is limited, however, because the dense, compact subsoil in both soils and the high content of sodium salts in the Harriet soil restrict root growth. Garrison creeping foxtail, reed canarygrass, and tall wheatgrass are the best suited species.

The Ranslo soil is suited to windbreaks and environmental plantings, but the Harriet soil generally is unsuited. All climatically suited trees and shrubs grow well on the Ranslo soil. Windbreaks and environmental plantings can be established on the Harriet soil, but optimum survival, growth, and vigor cannot be expected.

These soils generally are unsuited to cultivated crops because of the flooding, the sodium affected subsoil, and the meandering channels.

The Ranslo soil is in capability unit Vw-1, Subirrigated range site; the Harriet soil is in capability unit VIw-4, Saline Lowland range site.

TaA—Tally fine sandy loam, 0 to 2 percent slopes. This deep, well drained, nearly level soil is on uplands. Areas are irregular in shape and 5 to 110 acres in size. Slopes are smooth or slightly convex.

Typically, the surface layer is dark grayish brown fine sandy loam about 8 inches thick. The subsoil is dark grayish brown, grayish brown, and pale brown, very friable sandy loam about 22 inches thick. The underlying material to a depth of 60 inches is light brownish gray and pale brown, calcareous loamy sand.

Included with this soil in mapping are small areas of Bryant, Bowdle, Manning, and Williams soils. These soils make up less than 20 percent of any one mapped area. Bryant soils contain more silt and clay throughout than the Tally soil. They are on slight rises. Bowdle and Manning soils are underlain by gravelly material. They are in positions on the landscape similar to those of the Tally soil. Williams soils formed in loamy glacial till and contain more clay throughout than the Tally soil. They are on the edges of some mapped areas.

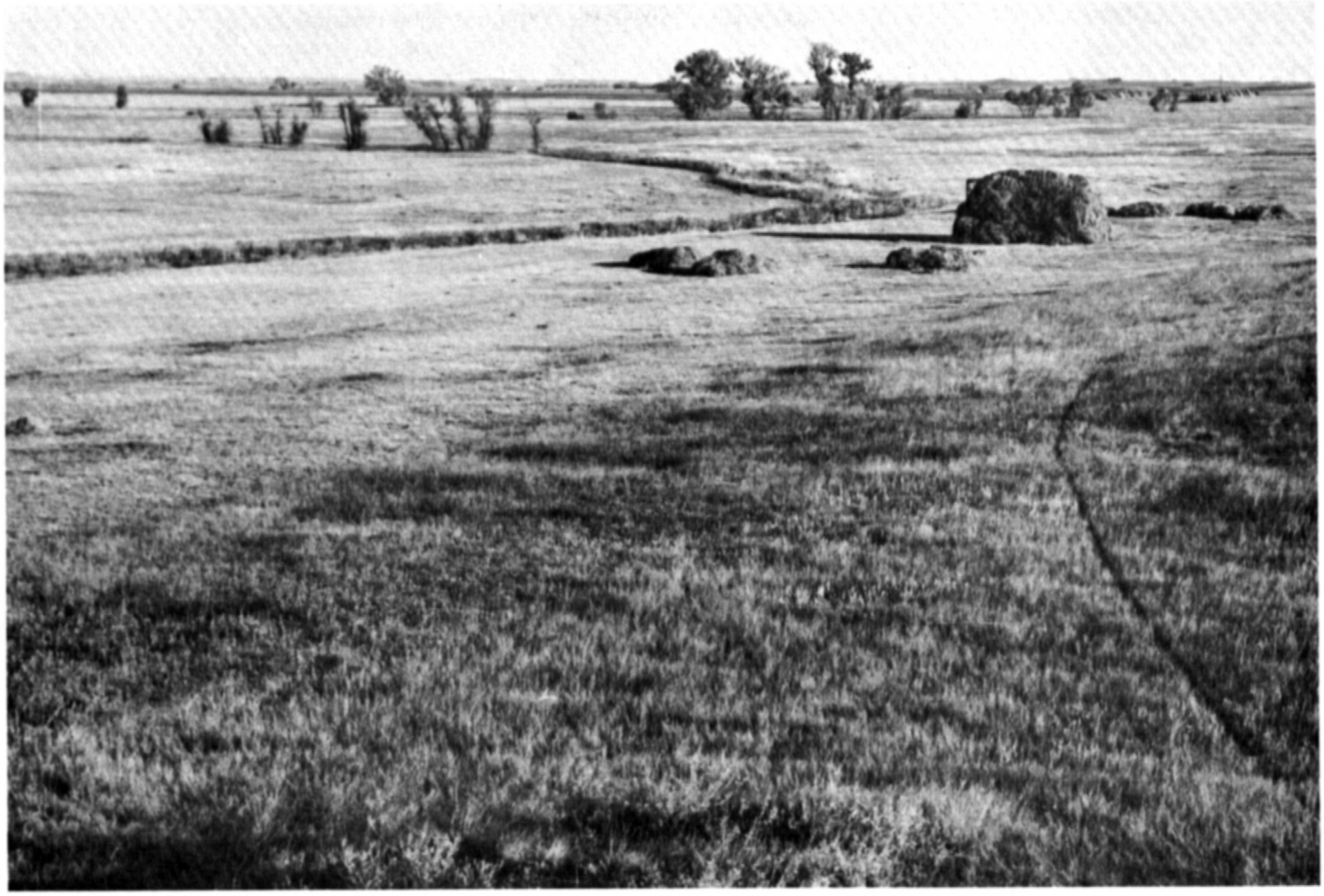

Figure 7.—An area of Ransio-Harriet silt loams used for hay.

Fertility is medium and organic matter content moderate in the Tally soil. Tilth is good. Permeability is moderately rapid. Available water capacity is low or moderate. Runoff is slow.

Most of the acreage is cropland. This soil is suited to cultivated crops. Measures that control wind erosion and conserve moisture are the main management needs. Examples are leaving crop residue on the surface, stripcropping, and establishing field windbreaks.

A cover of tame pasture plants or hay is effective in controlling wind erosion. A mulch of crop residue helps to control wind erosion until the pasture plants are established. Suitable species are alfalfa, intermediate wheatgrass, and smooth bromegrass.

This soil is suited to range. The native vegetation dominantly is little bluestem and lesser amounts of needleandthread and prairie sandreed. Overused areas are dominated by prairie sandreed, needleandthread, and other less palatable species. If overuse continues, sand dropseed, blue grama, Kentucky bluegrass, and weeds dominate the site.

This soil is well suited to windbreaks and environmental plantings. All climatically suited trees and shrubs grow well, except for those that require an abundant supply of moisture. Preparing the site for planting in the spring reduces the hazard of wind erosion.

The capability unit is IIIe-7; Sandy range site.

TaB—Tally fine sandy loam, 2 to 6 percent slopes. This deep, well drained, nearly level and undulating soil is on uplands. Areas are irregular in shape and 5 to 30 acres in size. Slopes are short and convex.

Typically, the surface layer is dark grayish brown fine sandy loam about 8 inches thick. The subsoil is dark grayish brown, grayish brown, and pale brown, very friable sandy loam about 22 inches thick. The underlying material to a depth of 60 inches is light brownish gray and pale brown, calcareous loamy sand.

Included with this soil in mapping are small areas of Bryant, Bowdle, Manning, and Williams soils. These soils make up less than 20 percent of any one mapped area.

Bryant soils contain more silt and clay throughout than the Tally soil. They are on some ridges. Bowdle and Manning soils are underlain by gravelly material. They are on ridges and side slopes. Williams soils formed in loamy glacial till and contain more clay throughout than the Tally soil. They are in positions on the landscape similar to those of the Tally soil.

Fertility is medium and organic matter content moderate in the Tally soil. Tilth is good. Permeability is moderately rapid. Available water capacity is low or moderate. Runoff is slow.

Most of the acreage is cropland. This soil is suited to most cultivated crops. Measures that control wind erosion and water erosion and conserve moisture are the main management needs. Leaving crop residue on the surface and stripcropping are examples.

A cover of tame pasture plants or hay is effective in controlling erosion. A mulch of crop residue helps to control wind erosion until the pasture plants are established. Suitable species are alfalfa, crested wheatgrass, intermediate wheatgrass, and smooth bromegrass.

This soil is suited to range. The native vegetation dominantly is little bluestem and lesser amounts of needleandthread and prairie sandreed. Overused areas are dominated by prairie sandreed, needleandthread, and other less palatable species. If overuse continues, sand dropseed, blue grama, Kentucky bluegrass, and weeds dominate the site.

This soil is suited to windbreaks and environmental plantings. All climatically suited trees and shrubs grow well, except for those that require an abundant supply of moisture. Preparing the site for planting in the spring reduces the hazard of wind erosion.

The capability unit is IIIe-8; Sandy range site.

Tn—Tonka-Nishon silt loams. These deep, poorly drained, level soils are in depressions in the uplands. The Tonka soil generally is in the center of the depressions and is surrounded by the Nishon soil. Both soils are ponded for long periods during spring runoff and after heavy rainfall. Areas are circular or oval and are 3 to 85 acres in size. They are 50 to 60 percent Tonka soil and 35 to 45 percent Nishon soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Tonka soil is dark gray silt loam about 8 inches thick. The subsurface layer is light gray, mottled silt loam about 13 inches thick. The subsoil is about 25 inches of dark gray and gray, firm clay and clay loam. The underlying material to a depth of 60 inches is light olive gray, mottled, calcareous clay loam. In some areas the surface layer is clay loam.

Typically, the surface layer of the Nishon soil is dark gray silt loam about 2 inches thick. The subsurface layer is light gray, mottled silt loam about 5 inches thick. The subsoil is dark gray, very firm silty clay about 25 inches thick. The underlying material to a depth of 60 inches is light olive gray, mottled, calcareous silty clay loam. In places the surface soil is less than 5 inches thick.

Fertility and organic matter content are high in the Tonka soil and low in the Nishon soil. Tilth is fair in the Tonka soil and poor in the Nishon soil. Available water capacity is high in the Tonka soil and moderate or high in the Nishon soil. Permeability is slow in both soils. During wet periods on both soils, a water table is within a depth of 1.0 foot. As much as 0.5 foot of water ponds on the surface during some wet periods. Runoff is ponded. The shrink-swell potential is high.

Most of the acreage supports native grasses and is used for grazing. These soils are suited to range. The native vegetation dominantly is sedges on the Tonka soil and western wheatgrass on the Nishon soil. Prairie cordgrass is a less extensive species on both soils. Overused areas are dominated by inland saltgrass, Kentucky bluegrass, foxtail barley, and curlycup gumweed. Smartweed, sedges, and rushes increase in extent during wet periods. Many areas are potential sites for excavated ponds.

Some areas are cultivated along with the surrounding areas. These soils are suited to cultivated crops, but the dense, compact subsoil and the ponding are limitations. Crops commonly drown out. Suitable drainage outlets generally are not available.

These soils are suited to tame pasture and hay, but the choice of suitable tame pasture plants is limited to water tolerant species, such as Garrison creeping foxtail and reed canarygrass. A drainage system cannot be installed in most areas.

These soils generally are unsuited to windbreaks and environmental plantings unless they are drained. The trees and shrubs that require an abundant supply of moisture grow well in drained areas.

The capability unit is IVw-1; the Tonka soil is in Wet Meadow range site, the Nishon soil in Closed Depression range site.

VaC—Vida-Williams very stony loams, 2 to 9 percent slopes. These deep, well drained, nearly level to gently rolling, very stony soils are on uplands. The Vida soil is on knolls and the upper side slopes. The Williams soil is on the lower side slopes and in nearly level areas. In many areas the surface stones are as much as 3 feet in diameter and 1 to 5 feet apart. Areas are irregular in shape and 5 to 30 acres in size. They are 45 to 55 percent Vida soil and 30 to 40 percent Williams soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Vida soil is dark grayish brown very stony loam about 6 inches thick. The subsoil is brown and light brownish gray, firm clay loam about 12 inches thick. It is calcareous in the lower part.

The underlying material to a depth of 60 inches is light brownish gray, mottled, calcareous loam.

Typically, the surface layer of the Williams soil is dark grayish brown very stony loam about 7 inches thick. The subsoil is dark grayish brown, brown, and light olive brown, firm and friable clay loam about 23 inches thick. It is calcareous in the lower part. The underlying material to a depth of 60 inches is pale yellow, mottled, calcareous clay loam.

Included with these soils in mapping are small areas of Bowbells, Niobell, Nishon, Noonan, and Tonka soils. These included soils make up less than 20 percent of any one mapped area. The moderately well drained Bowbells soils are dark to a depth of more than 16 inches. They are in swales and on the lower foot slopes. Niobell and Noonan soils have a sodium affected subsoil. They are on the lower side slopes. The poorly drained Nishon and Tonka soils are in depressions.

Fertility is medium and organic matter content moderate in the Vida and Williams soils. Tilth is good. Available water capacity is high. Permeability is moderate in the subsoil of both soils and moderately slow in the underlying material. Runoff is medium. The shrink-swell potential is moderate.

All of the acreage supports native grasses and is used for grazing. These soils are suited to range. The native vegetation dominantly is green needlegrass, needleandthread, bluestems, sideoats grama, and western wheatgrass. Overused areas are dominated by western wheatgrass and needleandthread. If overuse continues, blue grama, buffalograss, and weeds dominate the site.

These soils are too stony for cultivated crops, tame pasture and hay, and windbreaks and environmental plantings. Removing the stones is impactical.

The capability unit is VIIs-6; Silty range site.

VdC—Vida-Williams-Bowbells loams, 2 to 9 percent slopes. These deep, nearly level to gently rolling soils are on uplands. The well drained Vida soil is on the upper side slopes and knolls. The well drained Williams soil is on the mid and upper side slopes. The moderately well drained Bowbells soil is on foot slopes and in swales. It is occasionally flooded. Scattered stones are on the surface in some areas of the Vida and Williams soils. Areas are irregularly shaped or long and narrow and are 5 to more than 150 acres in size. They are 30 to 40 percent Vida soil, 25 to 35 percent Williams soil, and 20 to 30 percent Bowbells soil. The three soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Vida soil is dark grayish brown loam about 6 inches thick. The subsoil is brown and light brownish gray, firm clay loam about 12 inches thick. It is calcareous in the lower part. The underlying material to a depth of 60 inches is light brownish gray, mottled, calcareous loam.

Typically, the surface layer of the Williams soil is dark grayish brown loam about 7 inches thick. The subsoil is dark grayish brown, brown, and light olive brown, firm and friable clay loam about 23 inches thick. It is calcareous in the lower part. The underlying material to a depth of 60 inches is pale yellow, mottled, calcareous clay loam.

Typically, the surface layer of the Bowbells soil is dark gray loam about 11 inches thick. The subsoil is dark grayish brown and grayish brown, friable clay loam about 16 inches thick. The underlying material to a depth of 60 inches is light brownish gray and light yellowish brown, mottled, calcareous clay loam.

Included with these soils in mapping are small areas of Niobell, Nishon, Noonan, Tonka, and Zahl soils. These included soils make up less than 20 percent of any one mapped area. Niobell and Noonan soils have a sodium affected subsoil. They are on the lower side slopes in some areas. The poorly drained Nishon and Tonka soils are in depressions. Zahl soils have lime at or near the surface. They are on knolls.

Fertility is medium in the Williams and Vida soils and high in the Bowbells soil. Organic matter content is moderate in the Williams and Vida soils and high in the Bowbells soil. Tilth is good in all three soils. Available water capacity is high. Permeability is moderate in the subsoil and moderately slow in the underlying material. The Bowbells soil has a seasonal high water table at a depth of 4 to 6 feet. Runoff is medium on the Vida and Williams soils and slow on the Bowbells soil. The shrink-swell potential is moderate in all three soils.

Most of the acreage is cropland. These soils are suited to cultivated crops, but the high content of lime near the surface of the Vida soil adversely affects the availability of plant nutrients. Measures that control erosion and improve fertility are the main management needs. Examples are including grasses and legumes in the cropping system and leaving crop residue on the surface. Other measures that help to control erosion are contour farming and terracing. In some areas, however, slopes are too short or too irregular for contouring and terracing. Grassed waterways help to keep gullies from forming. In some areas the surface stones hinder the use of farm machinery.

A cover of tame pasture plants or hay is effective in controlling erosion. Alfalfa, intermediate wheatgrass, and smooth bromegrass are suitable pasture plants.

These soils are suited to range. The native vegetation on the Vida and Williams soils dominantly is green needlegrass, western wheatgrass, and needleandthread. That on the Bowbells soil is big bluestem and lesser amounts of western wheatgrass and green needlegrass. Overused areas are dominated by western wheatgrass and needleandthread. If overuse continues, blue grama, Kentucky bluegrass, and weeds dominate the site.

These soils are suited to windbreaks and environmental plantings. All climatically suited trees and shrubs grow well on the Vida and Williams soils, except for those that require an abundant supply of moisture. Those that require an abundant moisture supply grow especially well on the Bowbells soil. Planting on the contour helps to control erosion and conserves moisture.

The Vida soil is in capability unit IVe-3, the Williams soil is in capability unit IIIe-2, and the Bowbells soil is in capability unit IIc-3; the Vida and Williams soils are in Silty range site, and the Bowbells soil is in Overflow range site.

WaD—Wabek loam, 9 to 25 percent slopes. This excessively drained, strongly sloping and moderately steep soil is on outwash plains and terraces. It is very shallow or shallow over sand and gravel. Scattered stones are on some of the higher hills and ridges. Areas are long and narrow and are 5 to 60 acres in size. Slopes are short and convex.

Typically, the surface layer is dark grayish brown loam about 8 inches thick. The upper part of the underlying material is dark grayish brown, calcareous gravelly sandy loam. The lower part to a depth of 60 inches is grayish brown and light brownish gray, calcareous sand and gravel. In some areas loamy glacial till is below a depth of 40 inches.

Included with this soil in mapping are small areas of the well drained Bowdle soils in swales and on foot slopes. These soils make up less than 10 percent of any one mapped area. They are 20 to 40 inches deep over sand and gravel.

Fertility and organic matter content are low in the Wabek soil. Because of the porous underlying material, root development is restricted and the soil is droughty. Available water capacity is very low or low. Permeability is very rapid. Runoff is slow.

Most of the acreage supports native grasses and is used for grazing. This soil is suited to range. Productivity is limited, however, because the soil is droughty. The native vegetation dominantly is needleandthread, blue grama, and threadleaf sedge. Overused areas are dominated by blue grama and threadleaf sedge. After continued overuse, bare areas are common and erosion is a serious problem.

This soil generally is unsuited to cultivated crops, tame pasture and hay, and windbreaks and environmental plantings. The shallow root zone and the low or very low available water capacity are the main limitations.

The capability unit is VIs-4; Very Shallow range site.

WbC—Wabek-Bowdle loams, 3 to 9 percent slopes. These gently sloping and moderately sloping soils are on ridges on outwash plains and terraces. The excessively drained Wabek soil is on the steeper parts of the landscape. It is shallow over sand and gravel. Scattered stones are on some ridgetops. The well drained Bowdle soil is on the lower side slopes. It is moderately deep over gravelly sand. Slopes generally are short and convex. Areas are 5 to 60 acres in size and generally are long and narrow. They are 40 to 50 percent Wabek soil and 35 to 45 percent Bowdle soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Wabek soil is dark grayish brown loam about 8 inches thick. The upper part of the underlying material is dark grayish brown, calcareous gravelly sandy loam. The lower part to a depth of 60 inches is grayish brown and light brownish gray, calcareous sand and gravel. In some areas loamy glacial till is below a depth of 40 inches.

Typically, the surface layer of the Bowdle soil is dark gray loam about 7 inches thick. The subsoil is dark grayish brown and grayish brown, friable loam about 14 inches thick. The underlying material to a depth of 60 inches is light brownish gray and pale brown, calcareous gravelly sandy loam and gravelly sand. In some areas loamy glacial till is below a depth of 40 inches. In other areas the depth to lime is less than 20 inches.

Included with these soils in mapping are small areas of Tally and Zahl soils. These included soils make up less than 15 percent of any one mapped area. The well drained Tally soils are not underlain by gravelly material. They are on some side slopes. Zahl soils formed in loamy glacial till. They are on some ridgetops.

Fertility is low in the Wabek soil and medium in the Bowdle soil. Organic matter content is low in the Wabek soil and high in the Bowdle soil. Tilth is good in both soils. Available water capacity is low or very low in the Wabek soil and low or moderate in the Bowdle soil. Permeability is very rapid in the Wabek soil. It is moderate in the subsoil of the Bowdle soil and rapid in the gravelly underlying material. Runoff is medium on the Bowdle soil and slow on the Wabek soil.

Most of the acreage supports native grasses and is used for grazing. These soils are suited to range. Productivity is limited, however, because the Wabek soil is droughty. The native vegetation on this soil dominantly is needleandthread, blue grama, and threadleaf sedge. That on the Bowdle soil dominantly is green needlegrass, western wheatgrass, and needleandthread. Overused areas are dominated by blue grama, sedges, and weeds on the Wabek soil and western wheatgrass, needleandthread, and blue grama on the Bowdle soil. After continued overuse, bare areas are common and erosion is a serious problem on the Wabek soil.

These soils generally are unsuited to cultivated crops, tame pasture and hay, and windbreaks and environmental plantings because they are droughty. Trees and shrubs can be established on the Bowdle soil, but optimum survival and growth are unlikely.

The Wabek soil is in capability unit VIs-4, Very Shallow range site; the Bowdle soil is in capability unit IIIe-6, Silty range site.

WnA—Williams-Bowbells loams, 0 to 3 percent slopes. These deep, nearly level soils are on uplands. The well drained Williams soil is on the higher parts of the landscape. In some areas scattered stones are on the surface. The moderately well drained Bowbells soil is in swales. It is occasionally flooded for very brief periods. Areas are irregular in shape and 4 to 1,000 acres in size. They are 60 to 70 percent Williams soil and 20 to 30 percent Bowbells soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Williams soil is dark grayish brown loam about 7 inches thick. The subsoil is dark grayish brown, brown, and light olive brown, firm and friable clay loam about 23 inches thick. It is calcareous in the lower part. The underlying material to a depth of 60 inches is pale yellow, mottled, calcareous clay loam. In some areas, the surface layer is thinner and lime is nearer the surface.

Typically, the surface layer of the Bowbells soil is dark gray loam about 11 inches thick. The subsoil is dark grayish brown and grayish brown, friable clay loam about 16 inches thick. The underlying material to a depth of 60 inches is light brownish gray and light yellowish brown, mottled, calcareous clay loam.

Included with these soils in mapping are small areas of Niobell, Nishon, Noonan, Tonka, and Zahl soils. These included soils make up less than 15 percent of any one mapped area. Niobell and Noonan soils have a sodium affected subsoil. They are slightly lower on the landscape than the Williams soil. The poorly drained Nishon and Tonka soils are in depressions. Zahl soils have a thin surface layer and have lime at or near the surface. They are on some of the knolls.

Fertility is medium and organic matter content moderate in the Williams soil. Fertility and organic matter content are high in the Bowbells soil. Tilth is good in both soils. Available water capacity is high. Permeability is moderate in the subsoil and moderately slow in the underlying material. The Bowbells soil has a seasonal high water table at a depth of 4 to 6 feet. Runoff is slow on both soils. The shrink-swell potential is moderate.

Most of the acreage is cropland. These soils are suited to cultivated crops and to alfalfa, intermediate wheatgrass, and smooth bromegrass for tame pasture and hay. Measures that conserve moisture are the main management needs. Leaving crop residue on the surface is an example. Because the Bowbells soil receives runoff from the adjacent soils, planting and harvesting are delayed during some wet periods. The additional moisture is beneficial, however, in most years. In some areas the stones on the surface of the Williams soil hinder the use of farm machinery.

These soils are suited to range. The native vegetation on the Williams soil dominantly is green needlegrass, western wheatgrass, and needleandthread. That on the Bowbells soil is big bluestem and lesser amounts of green needlegrass and western wheatgrass. Overused areas are dominated by western wheatgrass, needleandthread, and Kentucky bluegrass.

These soils are suited to windbreaks and environmental plantings. All climatically suited trees and shrubs grow well on the Williams soil, except for those that require an abundant supply of moisture. Those that require an abundant moisture supply grow especially well on the Bowbells soil.

The Williams soil is in capability unit IIc-2, Silty range site; the Bowbells soil is in capability unit IIc-3, Overflow range site.

WnB—Williams-Bowbells loams, 1 to 6 percent slopes. These deep, nearly level and undulating soils are on uplands. The well drained Williams soil is in convex areas. In some of these areas scattered stones are on the surface and throughout the soil. The moderately well drained Bowbells soil is in swales. It is occasionally flooded for very brief periods. Areas are irregular in shape and 10 to more than 700 acres in size. They are 55 to 65 percent Williams soil and 20 to 30 percent Bowbells soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Williams soil is dark grayish brown loam about 7 inches thick. The subsoil is dark grayish brown, brown, and light olive brown, firm and friable clay loam about 23 inches thick. It is calcareous in the lower part. The underlying material to a depth of 60 inches is pale yellow, mottled, calcareous clay loam. In some areas, the surface layer is thinner and lime is nearer the surface.

Typically, the surface layer of the Bowbells soil is dark gray loam about 11 inches thick. The subsoil is dark grayish brown and grayish brown, friable clay loam about 16 inches thick. The underlying material to a depth of 60 inches is light brownish gray and light yellowish brown, mottled, calcareous clay loam.

Included with these soils in mapping are small areas of Niobell, Nishon, Noonan, Tonka, and Zahl soils. These included soils make up less than 20 percent of any one mapped area. Niobell and Noonan soils have a sodium affected subsoil. They are slightly lower on the landscape than the Williams soil. The poorly drained Nishon and Tonka soils are in depressions. Zahl soils have a thin surface layer and have lime at or near the surface. They are on knolls.

Fertility is medium and organic matter content moderate in the Williams soil. Fertility and organic matter content are high in the Bowbells soil. Tilth is good in both soils. Available water capacity is high. Permeability is moderate in the subsoil and moderately slow in the underlying material. The Bowbells soil has a seasonal high water table at a depth of 4 to 6 feet. Runoff is medium on the Williams soil and slow on the Bowbells soil. The shrink-swell potential is moderate in both soils.

Most of the acreage is cropland. These soils are suited to cultivated crops. Measures that control erosion and conserve moisture are the main management needs. Leaving crop residue on the surface is an example. Contour farming and terraces also can help to control erosion, but in some areas slopes are too short and too irregular for contouring and terracing. Grassed waterways help to keep gullies from forming. Because the Bowbells soil receives runoff from the adjacent soils, planting and harvesting are delayed during some wet periods. The additional moisture is beneficial, however, in most years. In some areas the surface stones hinder the use of farm machinery.

These soils are suited to tame pasture and hay. Examples of suitable pasture plants are alfalfa, intermediate wheatgrass, and smooth bromegrass.

These soils are suited to range. The native vegetation on the Williams soil dominantly is green needlegrass, western wheatgrass, and needleandthread. That on the Bowbells soil is big bluestem and lesser amounts of green needlegrass and western wheatgrass. Overused areas are dominated by western wheatgrass, needleandthread, and Kentucky bluegrass.

These soils are well suited to windbreaks and environmental plantings. All climatically suited trees and shrubs grow well on the Williams soil, except for those that require an abundant supply of moisture. Those that require an abundant moisture supply grow especially well on the Bowbells soil.

The Williams soil is in capability unit IIe-2, Silty range site; the Bowbells soil is in capability unit IIc-3, Overflow range site.

WoA—Williams-Bowbells-Nishon complex, 0 to 3 percent slopes. These deep, level and nearly level soils are on uplands. The well drained Williams soil is on slight rises, the moderately well drained Bowbells soil is in swales, and the poorly drained Nishon soil is in depressions. The Bowbells soil is occasionally flooded for very brief periods, and the Nishon soil is ponded for long periods. In some convex areas scattered stones are on the surface. Areas are 10 to 1,000 acres in size and irregular in shape. They are 45 to 55 percent Williams soil, 20 to 30 percent Bowbells soil, and 15 to 25 percent Nishon soil. The three soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Williams soil is dark grayish brown loam about 7 inches thick. The subsoil is dark grayish brown, brown, and light olive brown, firm and friable clay loam about 23 inches thick. It is calcareous in the lower part. The underlying material to a depth of 60 inches is pale yellow, mottled, calcareous clay loam. In some areas the subsoil is thinner and lime is near the surface.

Typically, the surface layer of the Bowbells soil is dark gray loam about 11 inches thick. The subsoil is dark grayish brown and grayish brown, friable clay loam about 16 inches thick. The underlying material to a depth of 60 inches is light brownish gray and light yellowish brown, mottled, calcareous clay loam.

Typically, the surface layer of the Nishon soil is dark gray silt loam about 2 inches thick. The subsurface layer is light gray, mottled silt loam about 5 inches thick. The subsoil is dark gray, very firm silty clay about 25 inches thick. The underlying material to a depth of 60 inches is light olive gray, mottled, calcareous silty clay loam. In places the surface soil is less than 5 inches thick.

Included with these soils in mapping are small areas of Niobell, Noonan, and Parnell soils. These included soils make up less than 15 percent of any one mapped area. The moderately well drained Niobell and Noonan soils are slightly lower on the landscape than the Williams soil. They have a sodium affected subsoil. The very poorly drained Parnell soils are in depressions.

Fertility is medium in the Williams soil, high in the Bowbells soil, and low in the Nishon soil. Organic matter content is moderate in the Williams soil, high in the Bowbells soil, and low in the Nishon soil. Tilth is good in the Williams and Bowbells soils and poor in the Nishon soil. Available water capacity is high in the Williams and Bowbells soils and moderate or high in the Nishon soil. Permeability is moderate in the subsoil of the Williams and Bowbells soils and moderately slow in the underlying material. It is slow in the Nishon soil. The Bowbells soil has a seasonal high water table at a depth of 4.0 to 6.0 feet. The Nishon soil has one within a depth of 1.0 foot. As much as 0.5 foot of water ponds on the surface of this soil during some wet periods. Runoff is slow on the Williams and Bowbells soils and ponded on the Nishon soil. The shrink-swell potential is moderate in the subsoil of the Williams and Bowbells soils and high in the Nishon soil.

Most of the acreage is cropland. These soils are suited to cultivated crops, but the wetness of the Nishon soil is a limitation. Because of the runoff from the Williams soil, planting and harvesting are delayed in some areas of the Bowbells and Nishon soils. Conserving moisture in the Williams and Bowbells soils and reducing the wetness of the Nishon soil are the main management concerns. Tillage practices that leave crop residue on the surface conserve moisture. In some areas of the Williams soil, the surface stones hinder the use of farm machinery.

These soils are suited to tame pasture and hay, but the wetness of the Nishon soil is a limitation. Alfalfa, intermediate wheatgrass, and smooth bromegrass are suitable for planting on the Williams and Bowbells soils. On the Nishon soil the choice of tame pasture plants is limited to water tolerant species, such as Garrison creeping foxtail and reed canarygrass.

These soils are suited to range. The native vegetation on the Williams and Bowbells soils dominantly is green needlegrass, western wheatgrass, bluestems, and needleandthread. That on the Nishon soil dominantly is western wheatgrass and lesser amounts of sedges and cordgrass. Overused areas of the Williams and Bowbells soils are dominated by western wheatgrass and needleandthread. After continued overuse, blue grama and Kentucky bluegrass dominate the site. Overused areas of the Nishon soil are dominated by buffalograss, saltgrass, sedges, and weeds. Many areas of this soil are potential sites for excavated ponds.

The Williams and Bowbells soils are suited to windbreaks and environmental plantings, but the Nishon soil generally is unsuited unless it is drained. All climatically suited trees and shrubs grow well on the Williams soil, except for those that require an abundant supply of moisture. Those that require an abundant moisture supply grow especially well on the Bowbells soil. No trees and shrubs grow well in undrained areas of the Nishon soil.

The Williams soil is in capability unit IIc-2, Silty range site; the Bowbells soil is in capability unit IIc-3, Overflow range site; the Nishon soil is in capability unit IVw-1, Closed Depression range site.

WoB—Williams-Bowbells-Nishon complex, 1 to 6 percent slopes. These deep, nearly level and undulating soils are on uplands. The well drained Williams soil is in areas on knolls and the upper side slopes where scattered stones generally are on the surface. The moderately well drained Bowbells soil is in swales. It is occasionally flooded for very brief periods. The poorly drained Nishon soil is in depressions. It is ponded for long periods in the spring and after heavy rainfall. Slopes generally are short and convex. Areas are 10 to 1,000 acres in size and irregular in shape. They are 40 to 50 percent Williams soil, 20 to 30 percent Bowbells soil, and 15 to 25 percent Nishon soil. The three soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Williams soil is dark grayish brown loam about 7 inches thick. The subsoil is dark grayish brown, brown, and light olive brown, firm and friable clay loam about 23 inches thick. It is calcareous in the lower part. The underlying material to a depth of 60 inches is pale yellow, mottled, calcareous clay loam. In some areas, the subsoil is thinner and lime is near the surface.

Typically, the surface layer of the Bowbells soil is dark gray loam about 11 inches thick. The subsoil is dark grayish brown and grayish brown, friable clay loam about 16 inches thick. The underlying material to a depth of 60 inches is light brownish gray and light yellowish brown, mottled, calcareous clay loam.

Typically, the surface layer of the Nishon soil is dark gray silt loam about 2 inches thick. The subsurface layer is light gray, mottled silt loam about 5 inches thick. The subsoil is dark gray, very firm silty clay about 25 inches thick. The underlying material to a depth of 60 inches is light olive gray, mottled, calcareous silty clay loam. In places the surface soil is less than 5 inches thick.

Included with these soils in mapping are small areas of Niobell, Noonan, Parnell, and Zahl soils. These included soils make up less than 15 percent of any one mapped area. The moderately well drained Niobell and Noonan soils are slightly lower on the landscape than the Williams soil. They have a sodium affected subsoil. The very poorly drained Parnell soils are in depressions. Zahl soils have lime at or near the surface. They are on knolls.

Fertility is medium in the Williams soil, high in the Bowbells soil, and low in the Nishon soil. Organic matter content is moderate in the Williams soil, high in the Bowbells soil, and low in the Nishon soil. Tilth is good in the Williams and Bowbells soils and poor in the Nishon soil. Available water capacity is high in the Williams and Bowbells soils and moderate or high in the Nishon soil. Permeability is moderate in the subsoil of the Williams and Bowbells soils and moderately slow in the underlying material. It is slow in the Nishon soil. The Bowbells soil has a seasonal high water table at a depth of 4.0 to 6.0 feet. The Nishon soil has one within a depth of 1.0 foot. As much as 0.5 foot of water ponds on the surface of this soil during some wet periods. Runoff is medium on the Williams soil, slow on the Bowbells soil, and ponded on the Nishon soil. The shrink-swell potential is moderate in the subsoil of the Williams and Bowbells soils and high in the Nishon soil.

Most of the acreage is cropland. These soils are suited to cultivated crops, but the wetness of the Nishon soil is a limitation. Because of the runoff from the Williams soil, planting and harvesting are delayed in some areas of the Bowbells and Nishon soils. Measures that control erosion and conserve moisture in areas of the Williams soil, conserve moisture in the Bowbells soil, and reduce the wetness on the Nishon soil are the main management needs. Leaving crop residue on the surface conserves moisture and helps to control erosion. Slopes are too short and too irregular in most areas for contour farming and terraces.

These soils are suited to tame pasture and hay, but the wetness of the Nishon soil is a limitation. Alfalfa, intermediate wheatgrass, and smooth bromegrass are suitable for planting on the Williams and Bowbells soils. On the Nishon soil the choice of pasture plants is limited to water tolerant species, such as Garrison creeping foxtail and reed canarygrass.

These soils are suited to range. The native vegetation on the Williams and Bowbells soils dominantly is green needlegrass, needleandthread, western wheatgrass, and bluestems. That on the Nishon soil dominantly is western wheatgrass and lesser amounts of sedges and cordgrass. Overused areas of the Williams and Bowbells soils are dominated by western wheatgrass and needleandthread. After continued overuse, blue grama and Kentucky bluegrass dominate the site. Overused areas of the Nishon soil are dominated by buffalograss, saltgrass, sedges, and weeds. Many areas of this soil are potential sites for excavated ponds.

The Williams and Bowbells soils are well suited to windbreaks and environmental plantings. All climatically suited trees and shrubs grow well on the Williams soil, except for those that require an abundant supply of moisture. Those that require an abundant moisture supply grow especially well on the Bowbells soil. The Nishon soil generally is unsuited to windbreaks and environmental plantings unless it is drained.

The Williams soil is in capability unit IIe-2, Silty range site; the Bowbells soil is in capability unit IIc-3, Overflow range site; the Nishon soil is in capability unit IVw-1, Closed Depression range site.

WpA—Williams-Bowbells-Noonan loams, 0 to 3 percent slopes. These deep, nearly level soils are on uplands. The well drained Williams soil is on slight rises. In some areas scattered stones are on the surface. The moderately well drained Bowbells soil is in swales. It is occasionally flooded for very brief periods. The moderately well drained Noonan soil is on side slopes and in swales. Areas are 10 to 300 acres in size and irregular in shape. They are 50 to 60 percent Williams soil, 15 to 25 percent Bowbells soil, and 15 to 25 percent Noonan soil. The three soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Williams soil is dark grayish brown loam about 7 inches thick. The subsoil is dark grayish brown, brown, and light olive brown, firm and friable clay loam about 23 inches thick. It is calcareous in the lower part. The underlying material to a depth of 60 inches is pale yellow, mottled, calcareous clay loam. In some areas, the subsoil is thinner and lime is near the surface.

Typically, the surface layer of the Bowbells soil is dark gray loam about 11 inches thick. The subsoil is dark grayish brown and grayish brown, friable clay loam about 16 inches thick. The underlying material to a depth of 60 inches is light brownish gray and light yellowish brown, mottled, calcareous clay loam.

Typically, the surface layer of the Noonan soil is grayish brown loam about 6 inches thick. The subsurface layer is light brownish gray loam about 2 inches thick. The subsoil is about 15 inches of brown and light yellowish brown, very firm, firm, and friable clay loam and loam. The underlying material to a depth of 60 inches is light gray and pale yellow, calcareous loam. In some areas the subsoil does not have columnar structure.

Included with these soils in mapping are small areas of Heil, Miranda, Nishon, and Tonka soils. These included soils make up less than 15 percent of any one mapped area. The poorly drained Heil, Nishon, and Tonka soils are in depressions. Miranda soils have visible salts within a depth of 16 inches. They are in small pits and depressions.

Fertility is medium in the Williams and Noonan soils and high in the Bowbells soil. Organic matter content is moderate in the Williams and Noonan soils and high in the Bowbells soil. The Noonan soil has a dense, compact subsoil that restricts root penetration. Tilth is good in the Williams and Bowbells soils and poor in the Noonan soil. Available water capacity is high in the Williams and Bowbells soils and moderate in the Noonan soil. Permeability is moderate in the subsoil of the Williams and Bowbells soils and moderately slow in the underlying material. It is slow in the Noonan soil. The Bowbells soil has a seasonal high water table at a depth of 4 to 6 feet. Runoff is slow on all three soils. The shrink-swell potential is moderate in the Williams and Bowbells soils. It is high in the subsoil of the Noonan soil and moderate in the underlying material.

Most of the acreage supports native grasses and is used for grazing. These soils are suited to range. The native vegetation on the Williams and Bowbells soils dominantly is bluestems, green needlegrass, needleandthread, and western wheatgrass. That on the Noonan soil dominantly is western wheatgrass and blue grama. Overused areas are dominated by blue grama, needleandthread, and western wheatgrass. After continued overuse, blue grama, buffalograss, and weeds dominate the site.

These soils are suited to cultivated crops, but the dense, compact subsoil in the Noonan soil restricts the penetration of plant roots. Measures that conserve moisture and improve tilth are the main management needs. Examples are leaving crop residue on the surface and including grasses and legumes in the cropping system. Other measures that improve tilth are timely tillage and chiseling or subsoiling.

These soils are suited to tame pasture and hay. Productivity is limited on the Noonan soil, however, because the dense, compact subsoil restricts root penetration. Alfalfa, crested wheatgrass, western wheatgrass, and intermediate wheatgrass are suitable pasture plants.

These soils are suited to windbreaks and environmental plantings, but the dense subsoil in the Noonan soil restricts root penetration. All climatically suited trees and shrubs grow well on the Williams soil, except for those that require an abundant supply of moisture. Those that require an abundant moisture supply grow especially well on the Bowbells soil. No trees or shrubs grow well in the Noonan soil.

The Williams soil is in capability unit IIc-2, Silty range site; the Bowbells soil is in capability unit IIc-3, Overflow range site; the Noonan soil is in capability unit IVs-2, Claypan range site.

WpB—Williams-Bowbells-Noonan loams, 1 to 6 percent slopes. These deep, nearly level and undulating soils are on uplands. The well drained Williams soil is on knolls and the mid and upper side slopes. In some areas scattered stones are on the surface. The moderately well drained Bowbells soil is in swales. It is occasionally flooded for very brief periods. The moderately well drained Noonan soil is on side slopes and in swales. Areas are 10 to 1,000 acres in size and irregular in shape. They are 45 to 55 percent Williams soil, 20 to 30 percent Bowbells soil, and 15 to 25 percent Noonan soil. The three soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Williams soil is dark grayish brown loam about 7 inches thick. The subsoil is dark grayish brown, brown, and light olive brown, firm and friable clay loam about 23 inches thick. It is calcareous in the lower part. The underlying material to a depth of 60 inches is pale yellow, mottled, calcareous clay loam. In some areas, the subsoil is thinner and lime is near the surface.

Typically, the surface layer of the Bowbells soil is dark gray loam about 11 inches thick. The subsoil is dark grayish brown and grayish brown, friable clay loam about 16 inches thick. The underlying material to a depth of 60 inches is light brownish gray and light yellowish brown, mottled, calcareous clay loam.

Typically, the surface layer of the Noonan soil is grayish brown loam about 6 inches thick. The subsurface layer is light brownish gray loam about 2 inches thick. The subsoil is about 15 inches of brown and light yellowish brown, very firm, firm, and friable clay loam and loam. The underlying material to a depth of 60 inches is light gray and pale yellow, calcareous loam. In some areas the subsoil does not have columnar structure.

Included with these soils in mapping are small areas of Heil, Miranda, Nishon, Tonka, and Zahl soils. These included soils make up less than 15 percent of any one mapped area. The poorly drained Heil, Nishon, and Tonka soils are in depressions. Miranda soils have visible salts within a depth of 16 inches. They are in small pits and depressions. Zahl soils have lime near the surface. They are on knolls.

Fertility is medium in the Williams and Noonan soils and high in the Bowbells soil. Organic matter content is moderate in the Williams and Noonan soils and high in the Bowbells soil. The Noonan soil has a dense, compact subsoil that restricts root penetration. Tilth is good in the Williams and Bowbells soils and poor in the Noonan soil. Available water capacity is high in the Williams and Bowbells soils and moderate in the Noonan soil. Permeability is moderate in the subsoil of the Williams and Bowbells soils and moderately slow in the underlying material. It is slow in the Noonan soil. The Bowbells soil has a seasonal high water table at a depth of 4 to 6 feet. Runoff is medium on all three soils. The shrink-swell potential is moderate in the Williams and Bowbells soils. It is high in the subsoil of the Noonan soil and moderate in the underlying material.

Most of the acreage supports native grasses and is used for grazing. These soils are suited to range. The native vegetation on the Williams and Bowbells soils dominantly is green needlegrass, western wheatgrass, needleandthread, and bluestems. That on the Noonan soil dominantly is western wheatgrass, green needlegrass, and blue grama. Overused areas are dominated by blue grama, western wheatgrass, and needleandthread. After continued overuse, blue grama, buffalograss, and weeds dominate the site.

These soils are suited to cultivated crops, but the dense, compact subsoil in the Noonan soil restricts the penetration of plant roots. Measures that conserve moisture, control erosion, and improve tilth are the main management needs. Examples are leaving crop residue on the surface and including grasses and legumes in the cropping system. Other measures that improve tilth are timely tillage and chiseling or subsoiling. Contour farming and terraces can help to control erosion, but in some areas slopes are too short or too irregular for contouring and terracing. Grassed waterways help to keep gullies from forming. In some areas of the Williams soil, the surface stones hinder the use of farm machinery.

These soils are suited to tame pasture and hay. Productivity is limited on the Noonan soil, however, because the dense, compact subsoil restricts root penetration. Alfalfa, western wheatgrass, and intermediate wheatgrass are suitable pasture plants.

These soils are suited to windbreaks and environmental plantings, but the dense subsoil in the Noonan soil restricts root penetration. All climatically suited trees and shrubs grow well on the Williams soil, except for those that require an abundant supply of moisture. Those that require an abundant moisture supply grow especially well on the Bowbells soil. No trees or shrubs grow well on the Noonan soil.

The Williams soil is in capability unit IIe-2, Silty range site; the Bowbells soil is in capability unit IIc-3, Overflow range site; the Noonan soil is in capability unit IVs-3, Claypan range site.

WtC—Williams-Bowbells-Parnell complex, 1 to 9 percent slopes. These deep, level to gently rolling soils are on uplands. The well drained Williams soil is in the higher convex areas where scattered stones generally are on the surface. The moderately well drained Bowbells soil is in swales. It is occasionally flooded for very brief periods. The very poorly drained Parnell soil is in depressions. It is ponded for long periods. Areas are 5 to 200 acres in size and irregular in shape. They are 30 to 40 percent Williams soil, 20 to 30 percent Bowbells soil, and 15 to 25 percent Parnell soil. The three soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Williams soil is dark grayish brown loam about 7 inches thick. The subsoil is dark grayish brown, brown, and light olive brown, firm and friable clay loam about 23 inches thick. It is calcareous in the lower part. The underlying material to a depth of 60 inches is pale yellow, mottled, calcareous clay loam. In some areas, the subsoil is thinner and lime is near the surface.

Typically, the surface layer of the Bowbells soil is dark gray loam about 11 inches thick. The subsoil is dark grayish brown and grayish brown, friable clay loam about 16 inches thick. The underlying material to a depth of 60 inches is light brownish gray and light yellowish brown, mottled, calcareous clay loam.

Typically, the surface layer of the Parnell soil is dark gray silty clay loam about 6 inches thick. The subsoil is dark gray, very firm silty clay about 44 inches thick. The underlying material to a depth of 60 inches is gray, mottled clay loam. In places the surface layer is clay loam.

Included with these soils in mapping are small areas of Lehr, Niobell, Noonan, and Zahl soils. These included soils make up less than 20 percent of any one mapped area. The somewhat excessively drained Lehr soils are 14 to 20 inches deep over gravelly material. They are on knolls. Niobell and Noonan soils have a sodium affected subsoil. They are on the lower side slopes and in swales. Zahl soils have a thin surface layer and have lime at or near the surface. They are on ridges and knolls.

Fertility is medium in the Williams soil and high in the Bowbells and Parnell soils. Organic matter content is moderate in the Williams soil and high in the Bowbells and Parnell soils. Tilth is good in the Williams and Bowbells soils and poor in the Parnell soil. Available water capacity is high in the Williams and Bowbells soils and moderate or high in the Parnell soil. Permeability is moderate in the subsoil of the Williams and Bowbells soils and moderately slow in the underlying material. It is slow in the Parnell soil. The Bowbells soil has a seasonal high water table at a depth of 4 to 6 feet. The Parnell soil has one within a depth of 2 feet. As much as 2 feet of water ponds on the surface of this soil during some wet periods. Runoff is medium on the Williams soil, slow on the Bowbells soil, and ponded on the Parnell soil. The shrink-swell potential is moderate in the Williams and Bowbells soils and high in the Parnell soil.

Nearly all of the acreage supports native grasses and is used for grazing. These soils are suited to range. The native vegetation on the Williams and Bowbells soils dominantly is green needlegrass, western wheatgrass, bluestems, and needleandthread. That on the Parnell soil dominantly is slough sedge, rivergrass, and prairie cordgrass. Overused areas of the Williams and Bowbells soils are dominated by western wheatgrass, needleandthread, Kentucky bluegrass, and weeds. Overused areas of the Parnell soil are dominated by sedges and rushes. Many areas of this soil are potential sites for excavated ponds.

These soils are suited to cultivated crops, but the wetness of the Parnell soil is a limitation. Fieldwork is delayed on the Bowbells soil during some wet periods. Measures that control erosion on the Williams soil and conserve moisture in the Bowbells soil are the main management needs. Leaving crop residue on the surface is an example. Slopes are too short and too irregular for contour farming and terracing. Grassed waterways help to keep gullies from forming. In some areas of the Williams soil, the surface stones hinder the use of farm machinery.

These soils are suited to tame pasture and hay, but the wetness of the Parnell soil is a limitation. Alfalfa, intermediate wheatgrass, and smooth bromegrass are suitable for planting on the Williams and Bowbells soils. On the Parnell soil the choice of tame pasture plants is limited to water tolerant species, such as Garrison creeping foxtail and reed canarygrass.

The Williams and Bowbells soils are suited to windbreaks and environmental plantings, but the Parnell soil generally is unsuited because of the ponding. All climatically suited trees and shrubs grow well on the Williams soil, except for those that require an abundant supply of moisture. Those that require an abundant moisture supply grow especially well on the Bowbells soil. Planting on the contour helps to control erosion and conserves moisture.

The Williams soil is in capability unit IIIe-2, Silty range site; the Bowbells soil is in capability unit IIc-3, Overflow range site; the Parnell soil is in capability unit Vw-4, Shallow Marsh range site.

WvB—Williams-Bowbells-Vida loams, 1 to 6 percent slopes. These deep, nearly level and undulating soils are on uplands. The well drained Williams soil is on side slopes. The moderately well drained Bowbells soil is in swales. It is occasionally flooded for very brief periods. The well drained Vida soil is on the upper side slopes and knolls (fig. 8). Scattered stones are on some of the knolls. Areas are 10 to 1,000 acres in size and irregular in shape. They are 45 to 55 percent Williams soil, 20 to 30 percent Bowbells soil, and 15 to 25 percent Vida soil. The three soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Williams soil is dark grayish brown loam about 7 inches thick. The subsoil is dark grayish brown, brown, and light olive brown, firm and friable clay loam about 23 inches thick. It is calcareous in the lower part. The underlying material to a depth of 60 inches is pale yellow, mottled, calcareous clay loam.

Typically, the surface layer of the Bowbells soil is dark gray loam about 11 inches thick. The subsoil is dark grayish brown and grayish brown, friable clay loam about 16 inches thick. The underlying material to a depth of 60 inches is light brownish gray and light yellowish brown, mottled, calcareous clay loam.

Typically, the surface layer of the Vida soil is dark grayish brown loam about 6 inches thick. The subsoil is

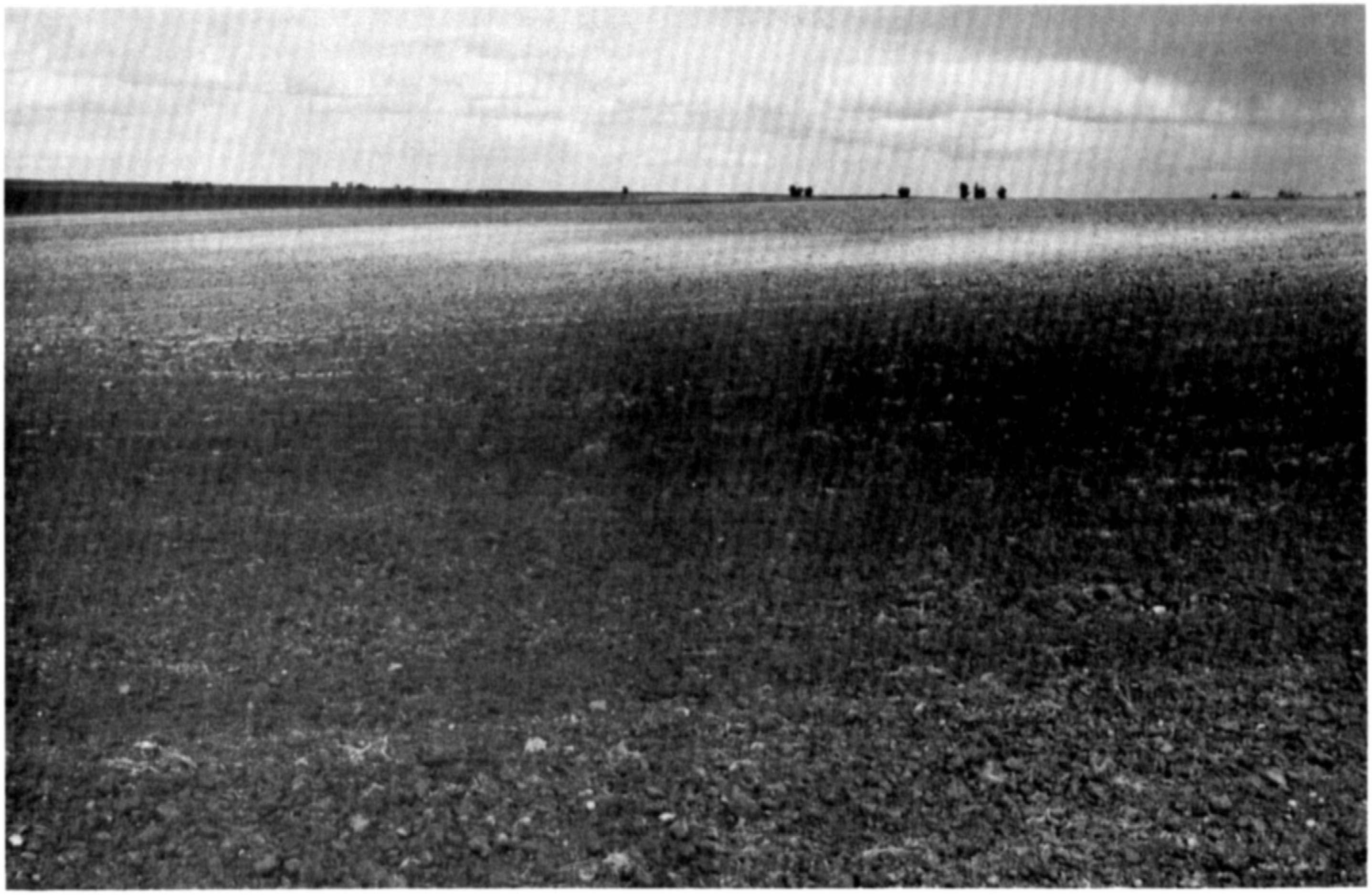

Figure 8.—An area of Williams-Bowbells-Vida loams, 1 to 6 percent slopes. The Vida soil is in the light colored areas.

brown and light brownish gray, firm clay loam about 12 inches thick. It is calcareous in the lower part. The underlying material to a depth of 60 inches is light brownish gray, mottled, calcareous loam.

Included with these soils in mapping are small areas of Nishon, Noonan, Tonka, and Zahl soils. These included soils make up less than 15 percent of any one mapped area. The poorly drained Nishon and Tonka soils are in depressions. The moderately well drained Noonan soils are on the lower side slopes. They have a sodium affected subsoil. Zahl soils have a thin surface layer and have lime at or near the surface. They are on some knolls.

Fertility is medium and organic matter content moderate in the Williams and Vida soils. Fertility and organic matter content are high in the Bowbells soil. Tilth is good in all three soils. Available water capacity is high. Permeability is moderate in the subsoil and moderately slow in the underlying material. The Bowbells soil has a seasonal high water table at a depth of 4 to 6 feet. Runoff is medium on the Williams and Vida soils and slow on the Bowbells soil. The shrink-swell potential is moderate in all three soils.

Most of the acreage is cropland. These soils are suited to cultivated crops. The high content of lime near the surface of the Vida soil adversely affects the availability of plant nutrients. Measures that conserve moisture, control erosion, and improve fertility are the main management needs. Examples are leaving crop residue on the surface and including grasses and legumes in the cropping system. Contour farming and terracing also can help to control erosion, but in some areas slopes are too short or too irregular for contouring or terracing. Grassed waterways help to keep gullies from forming. In some areas of the Williams and Vida soils, the surface stones hinder the use of farm machinery.

A cover of hay or tame pasture plants is effective in controlling erosion and improving fertility. These soils are suited to tame pasture and hay. Alfalfa, intermediate wheatgrass, and smooth bromegrass are suitable pasture plants.

These soils are suited to range. The native vegetation dominantly is green needlegrass, western wheatgrass, needleandthread, and bluestems. Overused areas are dominated by western wheatgrass and needleandthread. If overuse continues, blue grama, Kentucky bluegrass, and weeds dominate the site.

These soils are suited to windbreaks and environmental plantings. All climatically suited trees and shrubs grow well on the Williams and Vida soils, except for those that require an abundant supply of moisture. Those that require an abundant moisture supply grow especially well on the Bowbells soil. Planting on the contour helps to control erosion and conserves moisture.

The Williams soil is in capability unit IIe-2, Silty range site; the Bowbells soil is in capability unit IIc-3, Overflow range site; the Vida soil is in capability unit IIIe-12, Silty range site.

WwB—Williams-Niobell-Noonan loams, 3 to 6 percent slopes. These deep, undulating soils are on uplands. The well drained Williams soil is on knolls and side slopes. Scattered stones are on the surface in some areas. The moderately well drained Niobell and Noonan soils are on foot slopes and in shallow swales. Slopes generally are short and convex. Areas are irregular in shape and 10 to 200 acres in size. They are 45 to 55 percent Williams soil, 15 to 25 percent Niobell soil, and 15 to 20 percent Noonan soil. The three soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Williams soil is dark grayish brown loam about 7 inches thick. The subsoil is dark grayish brown, brown, and light olive brown, firm and friable clay loam about 23 inches thick. It is calcareous in the lower part. The underlying material to a depth of 60 inches is pale yellow, mottled, calcareous clay loam. In some areas, the subsoil is thinner and lime is near the surface.

Typically, the surface layer of the Niobell soil is dark grayish brown loam about 7 inches thick. The subsurface layer is about 5 inches of grayish brown and gray loam and silt loam. The subsoil is dark grayish brown and brown, firm clay loam about 14 inches thick. The underlying material to a depth of 60 inches is grayish brown and light brownish gray, mottled, calcareous loam.

Typically, the surface layer of the Noonan soil is grayish brown loam about 6 inches thick. The subsurface layer is light brownish gray loam about 2 inches thick. The subsoil is about 15 inches of brown and light yellowish brown, very firm, firm, and friable clay loam and loam. The underlying material to a depth of 60 inches is light gray and pale yellow, calcareous loam.

Included with these soils in mapping are small areas of Bowbells, Miranda, Nishon, Tonka, and Zahl soils. These included soils make up less than 20 percent of any one mapped area. The moderately well drained Bowbells soils are in swales. Miranda soils have visible salts within a depth of 16 inches. They are in small pits and depressions. The poorly drained Nishon and Tonka soils are in depressions. Zahl soils have a thin surface layer and have lime near the surface. They are on some knolls.

Fertility is medium and organic matter content moderate in the Williams, Niobell, and Noonan soils. The sodium affected subsoil of the Niobell and Noonan soils restricts the penetration of plant roots. Tilth is good in the Williams and Niobell soils and poor in the Noonan soil. Available water capacity is high in the Williams soil, moderate or high in the Niobell soil, and moderate in the Noonan soil. Permeability is moderate in the subsoil of the Williams soil and moderately slow in the underlying material. It is slow in the Niobell and Noonan soils. Runoff is medium on all three soils. The shrink-swell potential is moderate in the Williams soil. It is high in the subsoil of the Niobell and Noonan soils and moderate in the underlying material.

Most of the acreage supports native grasses and is used for grazing. These soils are suited to range. The native vegetation on the Williams soil dominantly is green needlegrass, western wheatgrass, and needleandthread. That on the Niobell and Noonan soils dominantly is western wheatgrass, blue grama, and green needlegrass. Overused areas are dominated by western wheatgrass and needleandthread. If overuse continues, Kentucky bluegrass, blue grama, buffalograss, and weeds dominate the site.

These soils are suited to cultivated crops. They are better suited to small grain than to late-maturing crops, such as corn, because the dense claypan subsoil in the Niobell and Noonan soils restricts the penetration of plant roots. Measures that conserve moisture, control erosion, increase the rate of water intake, and improve tilth are the main management needs. Examples are leaving crop residue on the surface and including grasses and legumes in the cropping system. Other measures that improve tilth and increase the rate of water intake are timely tillage and chiseling or subsoiling. Contour farming and terracing can help to control erosion, but in most areas slopes are too short or too irregular for contouring or terracing. Grassed waterways help to keep gullies from forming.

These soils are suited to tame pasture and hay, but the dense, compact subsoil in the Noonan soil limits the choice of pasture plants and productivity. Alfalfa, intermediate wheatgrass, and pubescent wheatgrass are examples of suitable pasture plants.

These soils are suited to windbreaks and environmental plantings, but the sodium affected subsoil in the Noonan soil is a limitation. All climatically suited trees and shrubs grow well on the Williams and Niobell soils, except for those that require an abundant supply of moisture. No trees or shrubs grow well on the Noonan soil because the dense subsoil severely restricts root penetration. Windbreaks and environmental plantings can be established on this soil, but optimum survival, growth, and vigor are unlikely.

The Williams soil is in capability unit IIe-2, Silty range site; the Niobell soil is in capability unit IIIe-3, Clayey range site; the Noonan soil is in capability unit IVs-3, Claypan range site.

WxC—Williams-Vida-Bowbells complex, 2 to 9 percent slopes. These deep, nearly level to gently rolling soils are on uplands. The well drained, stony Williams soil is on the mid and upper side slopes. The well drained, stony Vida soil is on knolls and narrow ridges. The moderately well drained Bowbells soil is in swales. It is occasionally flooded for very brief periods. Areas are irregular in shape and 5 to 1,000 acres in size. They are 35 to 45 percent Williams soil, 20 to 30 percent Vida soil, and 20 to 30 percent Bowbells soil. The three soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Williams soil is dark grayish brown stony loam about 7 inches thick. The subsoil is dark grayish brown, brown, and light olive brown, firm and friable clay loam about 23 inches thick. It is calcareous in the lower part. The underlying material to a depth of 60 inches is pale yellow, mottled, calcareous clay loam.

Typically, the surface layer of the Vida soil is dark grayish brown stony loam about 6 inches thick. The subsoil is brown and light brownish gray, firm clay loam about 12 inches thick. It is calcareous in the lower part. The underlying material to a depth of 60 inches is light brownish gray, mottled, calcareous loam.

Typically, the surface layer of the Bowbells soil is dark gray loam about 11 inches thick. The subsoil is dark grayish brown and grayish brown, friable clay loam about 16 inches thick. The underlying material to a depth of 60 inches is light brownish gray and light yellowish brown, mottled, calcareous clay loam.

Included with these soils in mapping are small areas of Niobell, Nishon, Noonan, Tonka, and Zahill soils. These included soils make up less than 20 percent of any one mapped area. Niobell and Noonan soils have a sodium affected subsoil. They are on some of the lower side slopes and on foot slopes. The poorly drained Nishon and Tonka soils are in depressions. Zahill soils have lime at or near the surface. They occur as areas intermingled with areas of the Vida soil on some knolls.

Fertility is medium in the Williams and Vida soils and high in the Bowbells soil. Organic matter content is moderate in the Williams and Vida soils and high in the Bowbells soil. Tilth is poor in the Williams and Vida soils and good in the Bowbells soil. Available water capacity is high in all three soils. Permeability is moderate in the subsoil and moderately slow in the underlying material. The Bowbells soil has a seasonal high water table at a depth of 4 to 6 feet. Runoff is medium on the Williams and Vida soils and slow on the Bowbells soil. The shrink-swell potential is moderate in all three soils.

Most of the acreage supports native grasses and is used for grazing. These soils are suited to range. The native vegetation on the Williams and Vida soils dominantly is green needlegrass, needleandthread, and western wheatgrass. That on the Bowbells soil dominantly is big bluestem, western wheatgrass, and green needlegrass. Overused areas are dominated by western wheatgrass and needleandthread. If overuse continues, blue grama, Kentucky bluegrass, and weeds dominate the site.

These soils are suited to cultivated crops and to alfalfa, intermediate wheatgrass, and smooth bromegrass for tame pasture and hay. The stoniness of the Williams and Vida soils is a limitation. The soils cannot be cropped unless the stones are removed. The high content of lime near the surface of the Vida soil adversely affects the availability of plant nutrients. Measures that control erosion, conserve moisture, and improve fertility are the main management needs. Examples are leaving crop residue on the surface and including grasses and legumes in the cropping system. Contour farming and terracing also can help to control erosion, but in some areas the slopes are too short or too irregular for contouring and terracing. Grassed waterways help to keep gullies from forming.

These soils are suited to windbreaks and environmental plantings if the stones are removed. All climatically suited trees and shrubs grow well on the Williams and Vida soils, except for those that require an abundant supply of moisture. Those that require an abundant moisture supply grow especially well on the Bowbells soil. Planting trees and shrubs on the contour helps to control erosion.

The Williams and Vida soils are in capability unit IVs-3, Silty range site; the Bowbells soil is in capability unit IIc-3, Overflow range site.

WzD—Williams-Zahill-Bowbells loams, 2 to 15 percent slopes. These deep, nearly level to rolling soils are on uplands. The well drained Williams soil is on the mid and upper side slopes. The well drained Zahill soil is on knolls and ridges. The moderately well drained Bowbells soil is in swales. It is occasionally flooded for very brief periods. Some areas are dissected by shallow drainageways. Scattered stones are on the surface in some areas of the Williams and Zahill soils. Slopes generally are short and convex. Areas are 10 to 1,000 acres in size and irregular in shape. They are 35 to 45 percent Williams soil, 20 to 30 percent Zahill soil, and 20 to 30 percent Bowbells soil. The three soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Williams soil is dark grayish brown loam about 7 inches thick. The subsoil is dark grayish brown, brown, and light olive brown, firm and friable clay loam about 23 inches thick. It is calcareous in the lower part. The underlying material to a depth of 60 inches is pale yellow, calcareous clay loam.

Typically, the surface layer of the Zahill soil is dark grayish brown, calcareous loam about 3 inches thick. The underlying material to a depth of 60 inches is grayish brown and light brownish gray, mottled, calcareous clay loam.

Typically, the surface layer of the Bowbells soil is dark gray loam about 11 inches thick. The subsoil is dark grayish brown and grayish brown, friable clay loam about 16 inches thick. The underlying material to a depth of 60 inches is light brownish gray and light yellowish brown, mottled, calcareous clay loam.

Included with these soils in mapping are small areas of Heil, Niobell, Noonan, Parnell, and Tonka soils. These included soils make up less than 15 percent of any one mapped area. The poorly drained Heil and Tonka and very poorly drained Parnell soils are in depressions. Niobell and Noonan soils have a sodium affected subsoil. They are on the lower side slopes.

Fertility is medium in the Williams soil, low in the Zahill soil, and high in the Bowbells soil. Organic matter content is moderate in the Williams soil, low in the Zahill soil, and high in the Bowbells soil. Tilth is good in all three soils. Available water capacity is high. Permeability is moderate in the subsoil of the Williams and Bowbells soils and moderately slow in the underlying material. It is moderately slow in the Zahill soil. The Bowbells soil has a seasonal high water table at a depth of 4 to 6 feet. Runoff is medium on all three soils. The shrink-swell potential is moderate.

Most of the acreage supports native grasses and is used for grazing. These soils are suited to range. The native vegetation dominantly is needlegrasses, bluestems, and western wheatgrass. Overused areas are dominated by western wheatgrass and needleandthread. If overuse continues, blue grama, Kentucky bluegrass, buffalograss, and weeds dominate the site.

This map unit is suited to cultivated crops, but erosion is a severe hazard on the Zahill soil. The high content of lime in the surface layer of this soil adversely affects the availability of plant nutrients. The stoniness in some areas of the Williams and Zahill soils also is a limitation. These areas generally cannot be cropped unless the stones are removed. Measures that control erosion and improve fertility are the main management needs. Examples are leaving crop residue on the surface and including grasses and legumes in the cropping system. Contour farming and terracing also can help to control erosion, but the slopes in most areas are too irregular for contouring and terracing. Grassed waterways help to keep gullies from forming.

A cover of hay or tame pasture plants is effective in controlling erosion. These soils are suited to tame pasture and hay. Productivity is limited on the Zahill soil, however, because the high content of lime in the surface layer adversely affects the availability of plant nutrients. Alfalfa, intermediate wheatgrass, and smooth bromegrass are suitable pasture plants.

These soils are suited to windbreaks and environmental plantings, but the high content of lime in the surface layer of the Zahill soil is a limitation. All climatically suited trees and shrubs grow well on the Williams soil, except for those that require an abundant supply of moisture. Those that require an abundant moisture supply grow especially well on the Bowbells soil. No trees or shrubs grow well on the Zahill soil.

The Williams soil is in capability unit IVe-1, Silty range site; the Zahill soil is in capability unit VIe-3, Thin Upland range site; the Bowbells soil is in capability unit IIc-3, Overflow range site.

ZaE—Zahill loam, 15 to 40 percent slopes. This deep, well drained, moderately steep and steep soil is on uplands. It commonly is on the sides of entrenched drainageways. In some areas scattered stones are on the surface. Areas generally are long and narrow and are 10 to 250 acres in size.

Typically, the surface layer is dark grayish brown, calcareous loam about 3 inches thick. The underlying material to a depth of 60 inches is grayish brown and light brownish gray, mottled, calcareous clay loam. In some areas the surface layer is thicker.

Included with this soil in mapping are small areas of Bowbells, Harriet, Ranslo, Vida, and Williams soils. These soils make up less than 20 percent of any one mapped area. The moderately well drained Bowbells soils are dark to a depth of more than 16 inches. They are in swales and on some foot slopes. The poorly drained Harriet and somewhat poorly drained Ranslo soils are on flood plains along narrow drainageways. They have a sodium affected subsoil. Vida and Williams soils are on some side slopes. They are deeper to lime than the Zahill soil. Also, they have a thicker surface layer and have a subsoil.

Fertility and organic matter content are low in the Zahill soil. Available water capacity is high. Permeability is moderately slow. Runoff is rapid. The shrink-swell potential is moderate.

All of the acreage supports native grasses and is used for grazing. This soil is suited to range. The native vegetation dominantly is little bluestem, sideoats grama, and western wheatgrass. Overused areas are dominated by needleandthread and blue grama. Many areas are potential sites for stock water impoundments (fig. 9).

This soil generally is too steep for cultivated crops, tame pasture and hay, and windbreaks and environmental plantings.

The capability unit is VIe-3; Thin Upland range site.

ZcE—Zahill very stony loam, 6 to 25 percent slopes. This deep, well drained, gently rolling to moderately steep, very stony soil is on upland knolls,

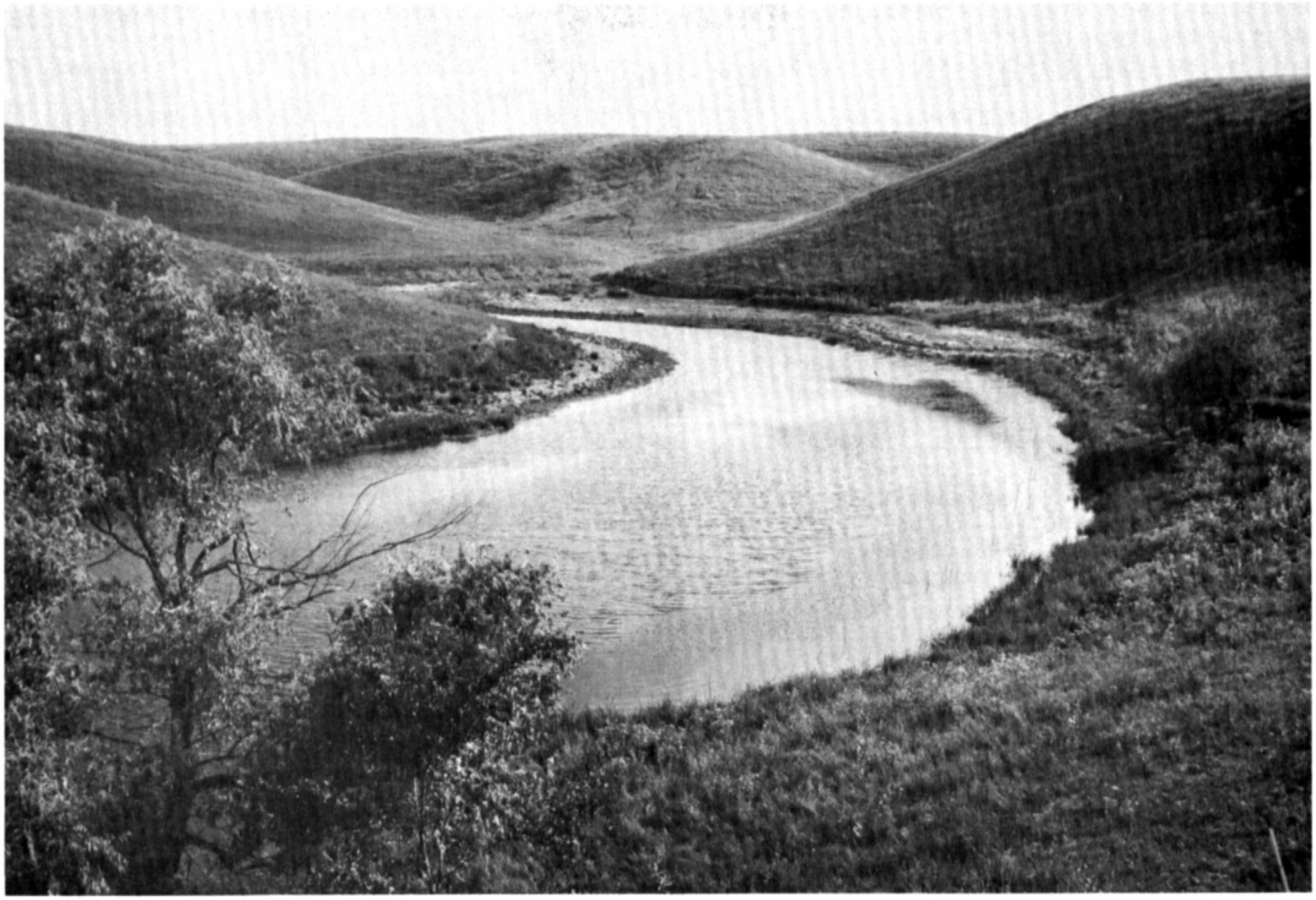

Figure 9.—A stock water impoundment in an area of Zahill loam, 15 to 40 percent slopes.

ridges, and side slopes. In some areas surface stones are as much as 5 feet in diameter and 1 to 5 feet apart. Slopes commonly are short and convex. Areas are long and narrow and are 7 to 65 acres in size.

Typically, the surface layer of the Zahill soil is dark grayish brown, calcareous very stony loam about 3 inches thick. The underlying material to a depth of 60 inches is grayish brown and light brownish gray, mottled, calcareous clay loam. In some areas the surface layer is thicker.

Included with this soil in mapping are small areas of Bowbells, Parnell, Wabek, and Williams soils. These soils make up less than 20 percent of any one mapped area. The moderately well drained Bowbells soils are on foot slopes and in swales. The very poorly drained Parnell soils are in depressions. The excessively drained Wabek soils are underlain by sand and gravel. They are on some ridges. Williams soils are on the lower side slopes. They are deeper to lime than the Zahill soil. Also, they have a thicker surface layer and have a subsoil.

Fertility and organic matter content are low in the Zahill soil. Available water capacity is high. Permeability is moderately slow. Runoff is rapid. The shrink-swell potential is moderate.

Most of the acreage supports native grasses and is used for grazing. This soil is suited to range. The native vegetation dominantly is little bluestem, sideoats grama, and western wheatgrass. Overused areas are dominated by needleandthread and sideoats grama.

This soil generally is too stony and too steep for cultivated crops, tame pasture and hay, and windbreaks and environmental plantings.

The capability unit is VIIs-6; Thin Upland range site.

ZlD—Zahill-La Prairie complex, 2 to 25 percent slopes. These deep soils are on uplands and flood plains. The moderately steep, well drained Zahill soil is on upland side slopes. Scattered stones are on the surface in most areas. The nearly level, moderately well drained La Prairie soil is on flood plains that are dissected by narrow channels. It is frequently flooded. Areas are long and narrow and are 30 to 230 acres in size. They are 35 to 45 percent Zahill soil and 25 to 35 percent La Prairie soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Zahill soil is dark grayish brown, calcareous loam about 3 inches thick. The underlying material to a depth of 60 inches is grayish brown and light brownish gray, mottled, calcareous clay loam. In some areas the surface layer is thicker.

Typically, the surface layer of the La Prairie soil is dark gray loam about 15 inches thick. The subsoil is dark gray, very friable, calcareous silt loam about 8 inches thick. The underlying material to a depth of 60 inches is grayish brown, calcareous silt loam. In some areas it is stratified with thin layers of loamy and sandy material.

Included with these soils in mapping are small areas of Bowbells, Harriet, Ranslo, Vida, Wabek, and Williams soils. These included soils make up less than 25 percent of any one mapped area. The moderately well drained Bowbells soils are dark to a depth of more than 16 inches. They are on the lower side slopes adjacent to the flood plains. The poorly drained Harriet and somewhat poorly drained Ranslo soils are on the flood plains adjacent to the channels. They have a sodium affected subsoil. The well drained Vida and Williams soils are on the upper side slopes. They are deeper to lime than the Zahill soil. Also, they have a thicker surface layer and have a subsoil. The excessively drained Wabek soils are underlain by gravelly material. They are on some ridges.

Fertility and organic matter content are low in the Zahill soil and high in the La Prairie soil. Available water capacity is high in both soils. Permeability is moderately slow in the Zahill soil and moderate in the La Prairie soil. The La Prairie soil has a water table at a depth of 3.5 to 6.0 feet during wet periods. Runoff is rapid on the Zahill soil and slow on the La Prairie soil. The shrink-swell potential is moderate in both soils.

Nearly all of the acreage supports native grasses and is used for grazing. These soils are suited to range. The native vegetation on the Zahill soil dominantly is little bluestem, sideoats grama, and western wheatgrass. That on the La Prairie soil dominantly is big bluestem, green needlegrass, and western wheatgrass. Overused areas of the Zahill soil are dominated by needleandthread. Overused areas of the La Prairie soil are dominated by western wheatgrass and Kentucky bluegrass.

Because of the moderately steep slope of the Zahill soil and the flooding on the La Prairie soil, these soils generally are unsuited to cultivated crops, tame pasture and hay, and windbreaks and environmental plantings.

The Zahill soil is in capability unit VIe-3, Thin Upland range site; the La Prairie soil is in capability unit VIw-1, Overflow range site.

ZmC—Zahl-Max loams, 6 to 9 percent slopes. These deep, well drained, moderately sloping soils are on uplands. The Zahl soil is on the higher knolls and steeper side slopes. The Max soil is on the mid and lower side slopes. In some areas scattered stones are on the surface. Areas are long and narrow and are 5 to 80 acres in size. They are 40 to 50 percent Zahl soil and 35 to 45 percent Max soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Zahl soil is grayish brown loam about 6 inches thick. The underlying material to a depth of 60 inches is grayish brown, light brownish gray, and pale yellow, calcareous loam. It is mottled in the lower part.

Typically, the surface layer of the Max soil is dark grayish brown loam about 8 inches thick. The subsoil is brown and light yellowish brown, friable loam about 13 inches thick. It is calcareous in the lower part. The underlying material to a depth of 60 inches is light brownish gray and pale yellow, calcareous loam. It is mottled in the lower part. In some areas the subsoil contains more clay.

Included with these soils in mapping are small areas of Lehr, Niobell, Noonan, and Tally soils. These included soils make up less than 15 percent of any one mapped area. The somewhat excessively drained Lehr soils have gravelly material within a depth of 20 inches. They are on knolls and the upper side slopes. The moderately well drained Niobell and Noonan soils are in swales and on foot slopes. They have a sodium affected subsoil. Tally soils contain less clay and more sand throughout than the Zahl and Max soils. They are on some of the side slopes.

Fertility is low in the Zahl soil and medium in the Max soil. Organic matter content is low in the Zahl soil and moderate in the Max soil. Available water capacity is high in both soils. Permeability is moderate in the upper part of the soils and moderately slow in the underlying material. Runoff is medium. The shrink-swell potential is moderate.

Most of the acreage is cropland. These soils are suited to cultivated crops, but the high content of lime in the surface layer of the Zahl soil adversely affects the availability of plant nutrients. Measures that control erosion and improve fertility are the main management needs. Examples are leaving crop residue on the surface and including grasses and legumes in the cropping system. Contour farming and terracing also can help to control erosion, but the slopes in most areas are too irregular or too short for contouring and terracing. Grassed waterways help to keep gullies from forming. The surface stones in some areas hinder the use of farm machinery.

A cover of hay or tame pasture plants is effective in controlling erosion. These soils are suited to tame pasture and hay. Examples of suitable pasture plants are alfalfa, intermediate wheatgrass, and smooth bromegrass.

These soils are suited to range. The native vegetation on the Zahl soil dominantly is little bluestem, green needlegrass, needleandthread, and western wheatgrass. That on the Max soil dominantly is green needlegrass, western wheatgrass, and needleandthread. Overused areas are dominated by western wheatgrass, needleandthread, and other less palatable species. If overuse continues, blue grama, Kentucky bluegrass, and weeds dominate the site.

These soils are suited to windbreaks and environmental plantings, but the high content of lime near the surface of the Zahl soil is a limitation. All climatically suited trees and shrubs grow well on the Max soil, except for those that require an abundant supply of moisture. No trees or shrubs grow well on the Zahl soil.

The Zahl soil is in capability unit IVe-3, Thin Upland range site; the Max soil is in capability unit IIIe-2, Silty range site.

ZmD—Zahl-Max loams, 9 to 20 percent slopes. These deep, well drained, strongly sloping and moderately steep soils are on ridges and side slopes in the uplands. They generally are on side slopes along large drainageways that dissect the uplands. The Zahl soil is on narrow ridges and the upper side slopes. The Max soil is on the mid and lower side slopes. In some areas scattered stones are on the surface. Areas are long and narrow and are 7 to 75 acres in size. They are 40 to 50 percent Zahl soil and 35 to 45 percent Max soil. The two soils occur as areas so closely intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Zahl soil is grayish brown loam about 6 inches thick. The underlying material to a depth of 60 inches is grayish brown, light brownish gray, and pale yellow, calcareous loam. It is mottled in the lower part.

Typically, the surface layer of the Max soil is dark grayish brown loam about 8 inches thick. The subsoil is brown and light yellowish brown, friable loam about 13 inches thick. It is calcareous in the lower part. The underlying material to a depth of 60 inches is light brownish gray and pale yellow, calcareous loam. It is mottled in the lower part.

Included with these soils in mapping are small areas of Lehr, Miranda, Noonan, and Wabek soils. These included soils make up less than 20 percent of any one mapped area. The somewhat excessively drained Lehr and excessively drained Wabek soils are on knolls and the upper side slopes. They are underlain by gravelly material. Miranda and Noonan soils have a sodium affected subsoil. They are on the lower foot slopes.

Fertility is low in the Zahl soil and medium in the Max soil. Organic matter content is low in the Zahl soil and moderate in the Max soil. Available water capacity is high in both soils. Permeability is moderate in the upper part of the soils and moderately slow in the underlying material. Runoff is rapid. The shrink-swell potential is moderate.

Most of the acreage supports native grasses and is used for grazing. These soils are suited to range. The native vegetation on the Zahl soil dominantly is little bluestem, green needlegrass, needleandthread, and western wheatgrass. That on the Max soil dominantly is green needlegrass, western wheatgrass, and needleandthread. Overused areas are dominated by western wheatgrass, needleandthread, and other less palatable species. If overuse continues, blue grama, Kentucky bluegrass, and weeds dominate the site.

These soils generally are unsuited to cultivated crops because of the slope. They are suited to tame pasture and hay. Productivity is limited on the Zahl soil, however, because the high content of lime near the surface adversely affects the availability of plant nutrients. Alfalfa, intermediate wheatgrass, and smooth bromegrass are examples of suitable pasture plants.

The Max soil is suited to windbreaks and environmental plantings, but the Zahl soil generally is unsuited. All climatically suited trees and shrubs grow well on the Max soil, except for those that require an abundant supply of moisture. No trees or shrubs grow well on the Zahl soil. Windbreaks can be established in the less sloping areas of this soil, but optimum growth and survival are unlikely. Planting on the contour helps to control erosion.

The capability unit is VIe-3; the Zahl soil is in Thin Upland range site, the Max soil in Silty range site.

Prime Farmland

Prime farmland is one of several kinds of important farmland defined by the U.S. Department of Agriculture. It is of major importance in providing the Nation's short- and long-range needs for food and fiber. Because the supply of high quality farmland is limited, the U.S. Department of Agriculture recognizes that responsible levels of government, as well as individuals, should encourage and facilitate the wise use of our Nation's prime farmland.

Prime farmland, as defined by the U.S. Department of Agriculture, is the land that is best suited to food, feed, forage, fiber, and oilseed crops. It may be cultivated land, pasture, woodland, or other land, but it is not urban and built-up land or water areas. It either is used for food or fiber crops or is available for those crops. The soil qualities, growing season, and moisture supply are those needed for a well managed soil economically to produce a sustained high yield of crops.

Prime farmland has an adequate and dependable supply of moisture. The temperature and growing season are favorable. The level of acidity or alkalinity is acceptable. Prime farmland has few or no rocks and is permeable to water and air. It is not excessively erodible or saturated with water for long periods and is not frequently flooded during the growing season. The slope ranges mainly from 0 to 6 percent. More detailed information about the criteria for prime farmland is available at the local office of the Soil Conservation Service.

About 9,300 acres in Faulk County, or nearly 1.5 percent of the total acreage, meets the requirements for prime farmland. Bowbells loam and La Prairie loam are the only soils that are considered prime farmland. Most of the acreage of these soils is cropland. The main crops are corn, small grain, and alfalfa.

The indication that the two soils are considered prime farmland does not constitute a recommendation for a particular land use. The extent of the two soils is shown in table 4. The location is shown on the detailed soil maps at the back of this publication. The soil qualities that affect use and management are described in the section "Detailed Soil Map Units."

Use and Management of the Soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavior characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as rangeland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

Crops and Pasture

Dennis F. Shoup, district conservationist, Soil Conservation Service, helped write this section.

General management needed for crops and pasture is suggested in this section. The crops or pasture plants best suited to the soils, including some not commonly grown in the survey area, are identified; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants are listed for the arable soils.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under "Detailed Soil Map Units." Specific information can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

About 55 percent of the acreage in Faulk County is used for cultivated crops or for tame pasture and hay (*3*). The major crops are alfalfa, corn, oats, and spring wheat. Barley, flax, millet, rye, sorghum, and sunflowers also are grown. Alfalfa is harvested mainly for hay, spring wheat and barley are grown as cash crops, oats is grown as a cash crop and as livestock feed, and corn is harvested for both silage and grain.

The potential of the soils in Faulk County for increased crop production is good. About 60,000 acres of potentially good cropland is used as range, 33,600 acres as pasture, and 16,000 acres as tame hayland (*11*). In addition to the reserve productive capacity represented by this land, food production could also be increased considerably by extending the latest crop production technology to all cropland in the county. This soil survey can greatly facilitate the application of such technology. The paragraphs that follow describe the management needed on the cropland in the county.

Water erosion reduces productivity and results in sedimentation. It is the major problem on more than half of the cropland, hayland, and pasture in Faulk County. It is a hazard on Bryant, Max, Mondamin, Vida, Williams, and other soils if the slope is more than 2 percent. Productivity is reduced when the more fertile surface layer is lost and part of the subsoil is incorporated into a plow layer. Loss of the surface layer is especially damaging on soils that have a claypan subsoil, such as Noonan, and on soils that have a thin surface layer, such as Vida and Zahl. Erosion also reduces the productivity of soils that tend to be droughty, such as Bowdle and Lehr. When erosion occurs, sediment rich in nutrients enters streams and lakes. Measures that control erosion minimize the pollution of streams and lakes by sediment and preserve water quality for fish and wildlife, recreation, and municipal use. They also reduce the amount of fertilizer needed in cropped areas by helping to prevent the removal of plant nutrients.

A cropping system that keeps a plant cover on the surface for extended periods holds soil losses to an amount that will not reduce the productive capacity of the soils. If a plant cover cannot protect the soil, careful management of crop residue is essential. Minimizing tillage and leaving crop residue on the surface increase the infiltration rate, reduce the runoff rate, and help to control erosion.

Terraces and diversions reduce the length of slopes and the runoff rate and help to control erosion on the gently sloping Bryant and Mondamin soils. In many areas Vida and Williams soils are poorly suited to terraces and diversions because of short slopes or an unfavorable subsoil, which would be exposed in terrace channels.

Wind erosion is a slight to severe hazard on many of the soils in the county. The hazard is especially severe on Manning and Tally soils. The soils that have a high content of lime in the surface layer, such as Zahill and Zahl, also are highly susceptible. Wind erosion can damage these soils in a few hours if winds are strong and the soils are dry and are not protected by a plant cover or surface mulch. An adequate plant cover, a cover of crop residue, stripcropping, and a rough surface help to control wind erosion. Windbreaks of suitable trees and shrubs also are effective in controlling wind erosion.

Information about the measures that control erosion on each kind of soil is contained in the Technical Guide, available in the local office of the Soil Conservation Service.

Soil drainage is the major management concern on the poorly drained Nishon and Tonka soils. Unless these soils are artificially drained, the wetness commonly retards plant growth. Open ditch drainage systems can remove the excess water if a drainage outlet is available. Controlling the runoff from the adjacent soils also helps to reduce the wetness of these soils.

The well drained Arnegard and moderately well drained Bowbells, Grassna, and La Prairie soils on stream terraces, flood plains, and flats and in upland swales receive additional moisture when streams occasionally overflow and when water runs off higher lying adjacent soils. Tillage and planting are delayed in the spring during wet years, but in most years natural drainage is adequate and the additional moisture is beneficial for crops. Artificial drainage is rarely needed on these soils.

Soil fertility helps to determine the level of yields. It can be improved by applying fertilizer and by including grasses and legumes in the cropping system. In soils that have a high content of lime in the surface layer, such as Zahill and Zahl, the kinds and amounts of fertilizer needed generally differ from the kinds and amounts needed on soils that do not have lime in the surface layer. On all soils additions of fertilizer should be based on the results of soil tests, on the need of the crop, and on the expected yield level. The Cooperative Extension Service can help in determining the kinds and amounts of fertilizer needed.

Soil tilth is an important factor in the germination of seeds and the infiltration of water into the soil. Soils with good tilth are granular and porous. If tilled when wet, Mondamin and Raber soils tend to be very cloddy when dry. As a result of the cloddiness, preparing a good seedbed is difficult. These soils dry out slowly in the spring and cannot be easily tilled when dry. Tilth is poor in claypan soils, such as Miranda and Noonan. Timely tillage, inclusion of grasses and legumes in the cropping system, and incorporation of crop residue into the soil improve tilth and increase the rate of water intake.

Field crops suited to the soils and climate of the survey area include small grain and row crops. Oats and spring wheat are the main small grain crops. Barley, flax, millet, and rye are grown on a lesser acreage. Corn is the main row crop. It commonly is harvested for silage. The acreage planted to sunflowers is increasing.

All commonly grown and climatically suited crops are suited to the deep, well drained or moderately well drained soils, such as Arnegard, Bowbells, Bryant, Grassna, Max, Mondamin, Vida, and Williams soils. Bowdle and Lehr soils are better suited to early maturing small grain than to deeper rooted crops, such as corn and alfalfa, because the porous underlying material limits the available water capacity and the depth to which roots can develop. The erosive Manning and Tally soils also are better suited to small grain, which provides better protection against wind erosion than row crops.

Pasture plants best suited to the climate and most of the soils in the survey area include alfalfa, intermediate wheatgrass, and smooth bromegrass. Crested wheatgrass is well suited to soils that tend to be droughty, such as Bowdle and Lehr. Bunch grasses, such as crested wheatgrass, should not be planted in areas where the slope is more than 6 percent because erosion is a hazard. Pubescent wheatgrass is suited to Noonan and other soils that have a dense claypan subsoil. The choice of pasture plants is limited to water tolerant species, such as Garrison creeping foxtail and reed canarygrass, on the poorly drained Heil, Nishon, and Tonka soils and the very poorly drained Parnell soils.

If the pasture is overgrazed, the grasses lose vigor and die and usually are replaced by annual grasses and by weeds. Proper stocking rates, timely deferment of grazing, and applications of fertilizer help to keep the pasture in good condition.

Yields Per Acre

The average yeilds per acre that can be expected of the principal crops under a high level of management are shown in table 5. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green manure crops; and harvesting that insures the smallest possible loss.

The estimated yields reflect the productive capacity of each soil listed for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 5 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is mall. The local office of the Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils.

Land Capability Classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The criteria used in grouping the soils do not include major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor do they include possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for woodland, and for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit (*9*). These levels are defined in the following paragraphs. Some survey areas do not have soils of all classes.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have slight limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e, w, s,* or *c,* to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is very cold or very dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w, s,* or *c* because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation.

Capability units are soil groups within a subclass. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example IIe-2 or IVe-1. The capability unit of each map unit is given in the section "Detailed Soil Map Units."

Rangeland

Dennis F. Shoup, district conservationist, Soil Conservation Service, helped write this section.

About 45 percent of the acreage of Faulk County is rangeland (*3*). More than half of the local farm income is derived from the sale of livestock, principally cattle. Cow-calf-steer enterprises are dominant throughout the county. The average size of farms or ranches is about 1,500 acres.

The rangeland generally occurs as scattered tracts throughout the county. The greatest concentration is in areas of the Williams-Bowbells-Vida, Williams-Zahill-Bowbells, Noonan-Miranda, and La Prairie-Zahill-Lehr soil associations, which are described under the heading

"General Soil Map Units." The soils used as rangeland generally are too steep, too stony, or too shallow over the underlying material for cultivated crops. Examples are the steeper areas of Williams, Zahill, and Zahl soils.

On many farms the forage produced on rangeland is supplemented by crop aftermath. In winter it is supplemented by protein concentrate. On some ranches the market weight of calves and yearlings is increased by creep feeding.

In areas that have similar climate and topography, differences in the kind and amount of vegetation produced on rangeland are closely related to the kind of soil. Effective management is based on the relationship between the soils and vegetation and water.

Table 6 shows, for nearly all of the soils in the survey area, the range site and the potential annual production of vegetation in favorable, average, and unfavorable years. An explanation of the column headings in table 6 follows.

A *range site* is a distinctive kind of rangeland that produces a characteristic natural plant community that differs from natural plant communities on other range sites in kind, amount, and proportion of range plants. The relationship between soils and vegetation was ascertained during this survey; thus, range sites generally can be determined directly from the soil map. Soil properties that affect moisture supply and plant nutrients have the greatest influence on the productivity of range plants. Soil reaction, salt content, and a seasonal high water table are also important.

Potential annual production is the amount of vegetation that can be expected to grow annually on well managed rangeland that is supporting the potential natural plant community. It includes all vegetation, whether or not it is palatable to grazing animals. It includes the current year's growth of leaves, twigs, and fruits of woody plants. It does not include the increase in stem diameter of trees and shrubs. It is expressed in pounds per acre of air-dry vegetation for favorable, average, and unfavorable years. In a favorable year, the amount and distribution of precipitation and the temperatures make growing conditions substantially better than average. In an unfavorable year, growing conditions are well below average, generally because of low available soil moisture.

Range management requires a knowledge of the kinds of soil and of the potential natural plant community. It also requires an evaluation of the present range condition. Range condition is determined by comparing the present plant community with the potential natural plant community on a particular range site. The more closely the existing community resembles the potential community, the better the range condition. Range condition is an ecological rating only.

The objective in range management is to control grazing so that the plants growing on a site are about the same in kind and amount as the potential natural plant community for that site. Such management generally results in the optimum production of vegetation, control of undesirable brush species, conservation of water, and control of wind erosion and water erosion. Sometimes, however, a range condition somewhat below the potential meets grazing needs, provides wildlife habitat, and protects soil and water resources.

The native vegetation in many parts of the county has been greatly depleted by continued excessive use. Much of the acreage that was once mixed prairie is now covered with short grasses and weeds. The amount of forage produced may be less than half of that originally produced. The productivity of the range can be increased by applying management that is effective on specific soils and range sites.

An adequate plant cover and ground mulch help to control erosion and increase the moisture supply by reducing the runoff rate. If the range is overgrazed, the more desirable tall grasses lose vigor and are replaced by less productive short grasses. Measures that prevent overgrazing help to keep the range in good condition. Crossfencing and properly distributed watering and salting facilities help to obtain a uniform distribution of grazing.

Native Woods and Windbreaks and Environmental Plantings

Dennis F. Shoup, district conservationist, Soil Conservation Service, helped write this section.

Native trees and shrubs grow on only about 500 acres in Faulk County. They generally grow as clumps and thickets in swales or adjacent to drainageways and sloughs. The early settlers used the native trees and shrubs as fuel and as a food supply. Today, the trees and shrubs are used mainly for wildlife habitat.

Scattered individual plants or clumps of American elm, common chokecherry, green ash, western snowberry, and wild rose are common on the Vida, Zahill, and Zahl soils along drainageways. Cottonwood and willow are on the margins of some sloughs and intermittent lakes and along the drainage channels on flood plains.

Windbreaks protect livestock, buildings, and yards from wind and snow. They also protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broadleaf and coniferous trees and shrubs provide the most protection.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field. The interval depends on the erodibility of the soil. Field windbreaks protect cropland and crops from wind, keep snow from blowing off fields, and provide food and cover for wildlife.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. To insure plant survival, a healthy planting stock of suitable species should be planted properly on a well prepared site and maintained in good condition.

Table 7 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various soils. The estimates in table 7 are based on measurements and observation of established plantings that have been given adequate care. They can be used as a guide in planning windbreaks and screens.

Grazing is detrimental to windbreaks and environmental plantings because the livestock compact the soil and remove the lower branches of the trees and shrubs. The compaction retards growth. Removal of the lower branches reduces the effectiveness of the windbreaks. Weeds and insects prevent maximum growth. Clean cultivation and applications of herbicide help to control weeds. Fallowing a year before planting helps to provide a reserve supply of moisture, which is needed before seedlings can be established. If the trees or shrubs are planted on Tally and other soils that are subject to wind erosion, the site should be prepared in the spring.

Additional information on planning windbreaks and screens and planting and caring for trees and shrubs can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service or from a nursery.

Wildlife Habitat

John B. Farley, biologist, Soil Conservation Service, helped write this section.

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

In table 8, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are barley, corn, oats, and sorghum.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are alfalfa, crested wheatgrass, intermediate wheatgrass, smooth bromegrass, and yellow sweetclover.

Wild herbaceous plants are native or naturally established grasses and forbs. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are beggartick, big and little bluestem, goldenrod, grama grasses, switchgrass, and western wheatgrass.

Hardwood trees are planted trees and shrubs that produce nuts or other fruit, buds, catkins, twigs, bark, and foliage. Soil properties and features that affect the growth of hardwood trees and shrubs are depth of the root zone, available water capacity, and wetness. Examples of these plants are American elm, boxelder, green ash, hackberry, and plains cottonwood. Examples of fruit-producing shrubs that are suitable for planting on soils rated *good* are American plum, common chokecherry, cotoneaster, crabapple, honeysuckle, and Russian-olive.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, and salinity. Examples of wetland plants are barnyardgrass, cordgrass, reeds, rushes, sedges, and smartweed.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are ditches, marshes, ponds, and shallow dugouts.

The habitat for various kinds of wildlife is described in the following paragraphs.

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with forbs, grasses, and shrubs. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The wildlife attracted to these areas include eastern cottontail, gray partridge, meadowlark, mourning dove, red fox, ring-necked pheasant, whitetail deer, and whitetail jackrabbit.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are beaver, ducks, geese, herons, mink, muskrat, and shore birds.

Habitat for rangeland wildlife consists of areas of shrubs and wild herbaceous plants. Wildlife attracted to rangeland include deer, lark bunting, meadowlark, sharp-tailed grouse, whitetail deer, and whitetail jackrabbit.

Engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil Properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations need to be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 to 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to (1) evaluate the potential of areas for residential, commercial, industrial, and recreation uses; (2) make preliminary estimates of construction conditions; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; (5) plan detailed onsite investigations of soils and geology; (6) locate potential sources of gravel, sand, earthfill, and topsoil; (7) plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and (8) predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

Building Site Development

Table 9 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, and local roads and streets. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock, a cemented pan, or a very firm dense layer; stone content; soil texture; and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and the depth to the water table.

Dwellings and small commercial buildings are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell potential, and organic layers can cause the movement of footings. A high water table, depth to bedrock or to a cemented pan, large stones, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 to 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material, a base of gravel, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock or to a cemented pan, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic supporting capacity.

Sanitary Facilities

Table 10 shows the degree and kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 10 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock or to a cemented pan, and flooding affect absorption of the effluent. Large stones and bedrock or a cemented pan interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to filter the effluent effectively. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons (aerobic) are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 10 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock or to a cemented pan, flooding, large stones, and content of organic matter.

Excessive seepage due to rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope, bedrock, and cemented pans can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 10 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock or to a cemented pan, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, soil reaction, and content of salts and sodium affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to wind erosion.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock, a cemented pan, or the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

Construction Materials

Table 11 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a *probable* or *improbable* source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and the depth to the water table is less than 1 foot. They may have layers of suitable material, but the material is less than 3 feet thick.

Sand and gravel are natural aggregates suitable for commercial use with a minimum of processing. Sand and gravel are used in many kinds of construction. Specifications for each use vary widely. In table 11, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

Water Management

Table 12 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas and for embankments, dikes, and levees. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, irrigation, terraces and diversions, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock, to a cemented pan, or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers; and potential frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock or to a cemented pan, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity or by toxic substances in the root zone, such as salts, sodium, or sulfur. Availability of drainage outlets is not considered in the ratings.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock or to a cemented pan. The performance of a system is affected by the depth of the root zone, the amount of salts or sodium, and soil reaction.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to reduce erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock or to a cemented pan affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of wind or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock or to a cemented pan affect the construction of grassed waterways. A hazard of wind erosion, low available water capacity, restricted rooting depth, toxic substances, such as salts or sodium, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

Soil Properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics. These results are reported in table 16.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classifications, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

Engineering Index Properties

Table 13 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil Series and Their Morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter (fig. 10). "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is as much as about 15 percent, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

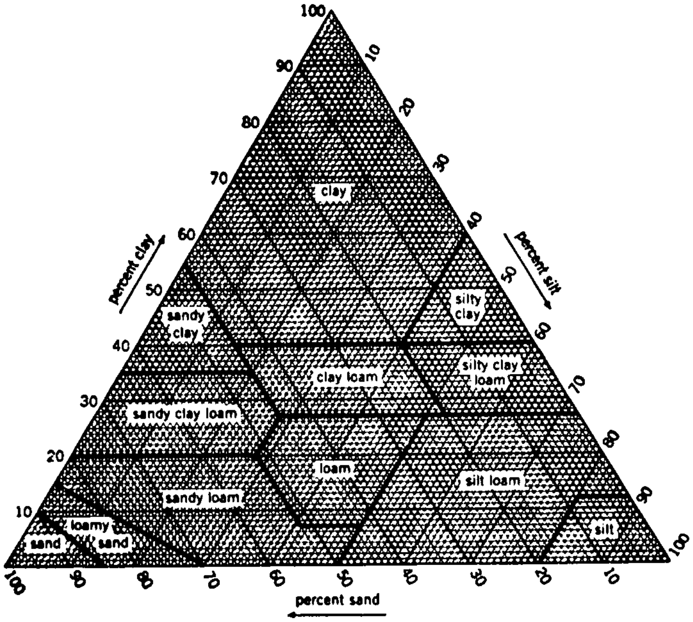

Figure 10.—Percentages of clay, silt, and sand in the basic USDA soil textural classes.

Classification of the soils is determined according to the Unified soil classification system (*2*) and the system adopted by the American Association of State Highway and Transportation Officials (*1*).

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as Pt. Soils exhibiting engineering properties of two groups can have a dual classification, for example, SP-SM.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest. The AASHTO classification for soils tested, with group index numbers in parentheses, is given in table 16.

Rock fragments larger than 3 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

Physical and Chemical Properties

Table 14 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Salinity is a measure of soluble salts in the soil at saturation. It is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25 degrees C. Estimates are based on field and laboratory measurements at representative sites of nonirrigated soils. The salinity of irrigated soils is affected by the quality of the irrigation water and by the frequency of water application. Hence, the salinity of soils in individual fields can differ greatly from the value given in the table. Salinity affects the suitability of a soil for crop production, the stability of soil if used as construction material, and the potential of the soil to corrode metal and concrete.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value, the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to wind erosion in cultivated areas. The groups indicate the susceptibility of soil to wind erosion and the amount of soil lost. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, fine sands, and very fine sands. These soils are generally not suitable for crops. They are extremely erodible, and vegetation is difficult to establish.

2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible. Crops can be grown if intensive measures to control wind erosion are used.

3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control wind erosion are used.

4L. Calcareous loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible. Crops can be grown if intensive measures to control wind erosion are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control wind erosion are used.

5. Loamy soils that are less than 18 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible. Crops can be grown if measures to control wind erosion are used.

6. Loamy soils that are 18 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible. Crops can easily be grown.

7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible. Crops can easily be grown.

8. Stony or gravelly soils and other soils not subject to wind erosion.

Organic matter is the plant and animal residue in the soil at various stages of decomposition.

In table 14, the estimated content of organic matter is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter of a soil can be maintained or increased by returning crop residue to the soil. Organic matter affects the available water capacity, infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

Soil and Water Features

Table 15 gives information helpful in planning land uses and engineering projects that are likely to be affected by soil and water features.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the intake of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

In table 15, some soils are assigned to two hydrologic groups. The first letter is for drained areas, and the second is for undrained areas.

Flooding, the temporary inundation of an area, is caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt and water in swamps and marshes are not considered flooding.

Table 15 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, common, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *common* that it is likely under normal conditions; *occasional* that it occurs on an average of once or less in 2 years; and *frequent* that it occurs on an average of more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months;

November-May, for example, means that flooding can occur during the period November through May.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding.

Also considered is local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 15 are the depth to the seasonal high water table; the kind of water table—that is, perched or apparent; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 15.

An *apparent* water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil. A *perched* water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Only saturated zones within a depth of about 6 feet are indicated. A plus sign preceding the range in depth indicates that the water table is above the surface of the soil. The first numeral in the range indicates how high the water rises above the surface. The second numeral indicates the depth below the surface.

Potential frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured clayey soils that have a high water table in winter are the most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage mainly to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low, moderate,* or *high,* is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low*, *moderate*, or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

Engineering Index Test Data

Table 16 shows laboratory test data for several pedons sampled at carefully selected sites in the survey area. The pedons are representative of the series. The soil samples were analyzed by the South Dakota Department of Transportation, Division of Highways.

The testing methods generally are those of the American Association of State Highway and Transportation Officials (AASHTO) or the American Society for Testing and Materials (ASTM).

The tests and methods are: AASHTO classification—M 145 (AASHTO), D 3282 (ASTM); Unified classification—D 2487 (ASTM); Mechanical analysis—T 88 (AASHTO), D 2217 (ASTM); Liquid limit—T 89 (AASHTO), D 423 (ASTM); Plasticity index—T 90 (AASHTO), D 424 (ASTM); and Moisture density, Method A—T 99 (AASHTO), D 698 (ASTM).

Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (*10*). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. In table 17, the soils of the survey area are classified according to the system. The categories are defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Mollisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Boroll (*Bor*, meaning cool, plus *oll*, from Mollisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Haploborolls (*Hapl*, meaning minimal horizonation, plus *boroll*, the suborder of the Mollisols that have a frigid soil temperature and an ustic moisture regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that typifies the great group. An example is Typic Haploborolls.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Mostly the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine-loamy, mixed, Typic Haploborolls.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the underlying material can differ within a series.

Soil Series and Their Morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. The soil is compared with similar soils and with nearby soils of other series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the *Soil Survey Manual* (*8*). Many of the technical terms used in the descriptions are defined in *Soil Taxonomy* (*10*). Unless otherwise stated, matrix colors in the descriptions are for dry soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed Soil Map Units."

Arnegard Series

The Arnegard series consists of deep, well drained soils formed in loamy alluvium and glacial till in swales on uplands. Permeability is moderate. Slopes range from 0 to 3 percent.

The Arnegard soils in this county are taxadjuncts to the Arnegard series because they have lower chroma in the A horizon than is defined as the range for the series. This difference, however, does not alter the usefulness or behavior of the soils.

Arnegard soils are similar to Bowbells and Grassna soils and commonly are near Max, Williams, and Zahl soils. Bowbells and Grassna soils are moderately well drained. Max, Williams, and Zahl soils have a mollic epipedon that is less than 16 inches thick. They are on side slopes, knolls, and ridges.

Typical pedon of Arnegard loam, in an area of Max-Arnegard-Zahl loams, 1 to 6 percent slopes, 2,478 feet east and 800 feet north of the southwest corner of sec. 14, T. 118 N., R. 66 W.

Ap—0 to 8 inches; dark gray (10YR 4/1) loam, very dark gray (10YR 3/1) moist; weak fine granular structure; slightly hard, very friable; neutral; abrupt smooth boundary.

Bw1—8 to 12 inches; dark grayish brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; weak coarse prismatic structure parting to weak medium subangular blocky; hard, friable; neutral; clear wavy boundary.

Bw2—12 to 17 inches; brown (10YR 5/3) loam, very dark grayish brown (2.5Y 3/2) moist; weak medium and coarse prismatic structure parting to moderate medium and coarse subangular blocky; hard, friable; neutral; clear wavy boundary.

BC—17 to 23 inches; brown (10YR 5/3) loam, dark grayish brown (2.5Y 4/2) moist; weak coarse prismatic structure parting to moderate fine and medium subangular blocky; hard, friable; neutral; abrupt wavy boundary.

Ck—23 to 31 inches; light brownish gray (2.5Y 6/2) loam, olive brown (2.5Y 4/4) moist; massive; hard, friable; common fine and medium accumulations of carbonate; strong effervescence; mildly alkaline; clear wavy boundary.

C—31 to 60 inches; light brownish gray (2.5Y 6/2) loam, olive brown (2.5Y 4/4) moist; common fine and medium distinct yellowish brown (10YR 5/8) and gray (10YR 5/1) mottles; massive; hard, friable; common fine and medium accumulations of carbonate; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 20 to 38 inches. The thickness of the mollic epipedon ranges from 16 to 28 inches. The depth to free carbonates ranges from 22 to 35 inches.

The A horizon has value of 3 or 4 (2 or 3 moist). It is 8 to 16 inches thick. It dominantly is loam but in some pedons is silt loam. The Bw horizon has hue of 10YR or 2.5Y, value of 3 to 5 (2 to 4 moist), and chroma of 2 or 3. It is loam or clay loam. The C horizon has value of 5 to 7 (4 or 5 moist). It is loam, fine sandy loam, or clay loam.

Bowbells Series

The Bowbells series consists of deep, moderately well drained soils formed in loamy alluvium and glacial till in upland swales and on foot slopes. Permeability is moderate in the subsoil and moderately slow in the underlying material. Slopes range from 0 to 3 percent.

The Bowbells soils in this county are taxadjuncts to the Bowbells series because they have lower chroma in the A horizon than is defined as the range for the series. This difference, however, does not alter the usefulness or behavior of the soils.

Bowbells soils are similar to Arnegard and Grassna soils and commonly are near Niobell, Noonan, and Williams soils. Arnegard and Grassna soils do not have an argillic horizon. Niobell and Noonan soils have a natric horizon. They are on flats and the lower side slopes and in swales. The well drained Williams soils are higher on the landscape than the Bowbells soils.

Typical pedon of Bowbells loam, in an area of Williams-Bowbells loams, 1 to 6 percent slopes, 900 feet east and 140 feet south of the northwest corner of sec. 15, T. 119 N., R. 69 W.

Ap—0 to 6 inches; dark gray (10YR 4/1) loam, black (10YR 2/1) moist; moderate fine granular structure; slightly hard, friable; slightly acid; abrupt smooth boundary.

A—6 to 11 inches; dark gray (10YR 4/1) loam, black (10YR 2/1) moist; weak medium subangular blocky structure parting to moderate medium granular; slightly hard, friable; slightly acid; clear smooth boundary.

Bt1—11 to 17 inches; dark grayish brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; moderate medium prismatic structure parting to moderate medium subangular blocky; hard, friable, slightly sticky and slightly plastic; neutral; clear wavy boundary.

Bt2—17 to 27 inches; grayish brown (10YR 5/2) clay loam, very dark grayish brown (10YR 3/2) moist; moderate medium prismatic structure parting to moderate medium subangular blocky; hard, friable, slightly sticky and slightly plastic; neutral; abrupt wavy boundary.

Ck—27 to 41 inches; light brownish gray (2.5Y 6/2) clay loam, light olive brown (2.5Y 5/4) moist; few medium prominent strong brown (7.5YR 5/8) mottles; massive; hard, friable; common fine accumulations of carbonate; strong effervescence; moderately alkaline; gradual wavy boundary.

C—41 to 60 inches; light yellowish brown (2.5Y 6/4) clay loam, light olive brown (2.5Y 5/4) moist; many fine and medium prominent strong brown (7.5YR 5/8) mottles; massive; hard, friable; few fine accumulations of carbonate; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 22 to 38 inches. The depth to free carbonates ranges from 22 to 36 inches. The thickness of the mollic epipedon ranges from 16 to 27 inches.

The A horizon has value of 3 or 4 (2 or 3 moist). It is 8 to 15 inches thick. It is loam, silt loam, or clay loam. It is slightly acid or neutral. The Bt horizon has hue of 10YR or 2.5Y, value of 4 to 6 (2 or 3 moist), and chroma of 2 or 3. It is clay loam or loam. It is slightly acid or neutral. Some pedons have a BC horizon. The C horizon has value of 4 to 6 (3 to 5 moist) and chroma of 2 to 4. It is loam or clay loam.

Bowdle Series

The Bowdle series consists of well drained soils that are moderately deep over gravelly material. These soils formed in loamy sediment over gravelly sand. They are on terraces. Permeability is moderate in the subsoil and rapid in the underlying material. Slopes range from 0 to 9 percent.

The Bowdle soils in this county are taxadjuncts to the Bowdle series because they have lower chroma in the A horizon than is defined as the range for the series. This difference, however, does not alter the usefulness or behavior of the soils.

Bowdle soils commonly are near Lehr, Manning, Tally, and Wabek soils. Lehr and Wabek soils have gravelly material within a depth of 20 inches. They are on ridges and knolls. Manning and Tally soils are in positions on the landscape similar to those of the Bowdle soils. They contain less clay in the subsoil than the Bowdle soils. Also, Tally soils do not have gravelly material within a depth of 40 inches.

Typical pedon of Bowdle loam, 0 to 3 percent slopes, 375 feet north and 120 feet west of the southeast corner of sec. 20, T. 119 N., R. 67 W.

Ap—0 to 7 inches; dark gray (10YR 4/1) loam, black (10YR 2/1) moist; weak fine granular structure; slightly hard, very friable; neutral; abrupt smooth boundary.

Bw1—7 to 15 inches; dark grayish brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; moderate medium prismatic structure parting to moderate medium subangular blocky; hard, friable; neutral; clear wavy boundary.

Bw2—15 to 21 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; moderate medium prismatic structure parting to moderate coarse and medium subangular blocky; hard, friable; neutral; clear wavy boundary.

Ck—21 to 24 inches; light brownish gray (10YR 6/2) gravelly sandy loam, dark grayish brown (10YR 4/2) moist; single grain; loose; strong effervescence; moderately alkaline; clear wavy boundary.

2C—24 to 60 inches; pale brown (10YR 6/3) gravelly sand, brown (10YR 4/3) moist; single grain; loose; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to free carbonates range from 17 to 30 inches. The thickness of the mollic epipedon ranges from 16 to 30 inches. The depth to gravelly material ranges from 20 to 40 inches.

The A horizon has value of 3 or 4 (2 or 3 moist). It is 5 to 8 inches thick. It dominantly is loam but in some pedons is silt loam. It is slightly acid or neutral. The B horizon has value of 3 to 5 (2 or 3 moist) and chroma of 1 or 2. The clay content in the part of the control section above the gravelly material averages as low as 18 percent in some pedons and as high as 25 percent in others. Some pedons have a BC horizon. The 2C horizon has hue of 10YR or 2.5Y, value of 4 to 6 (3 to 5 moist), and chroma of 2 to 4.

Bryant Series

The Bryant series consists of deep, well drained soils formed in silty glacial till on uplands. Permeability is moderate. Slopes range from 0 to 6 percent.

Bryant soils are similar to Max soils and commonly are near Grassna, Max, Mondamin, Tonka, and Williams soils. Grassna soils have a mollic epipedon that is more than 16 inches thick. They are in swales. Max and Williams soils contain more sand throughout than the Bryant soils. They are in positions on the landscape similar to those of the Bryant soils. Mondamin soils contain more clay in the subsoil than the Bryant soils. Also, they are higher on the landscape. The poorly drained Tonka soils are in depressions.

Typical pedon of Bryant silt loam, in an area of Bryant-Grassna silt loams, 0 to 2 percent slopes, 1,650 feet north and 220 feet east of the southwest corner of sec. 16, T. 118 N., R. 70 W.

Ap—0 to 6 inches; dark grayish brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; moderate fine and medium granular structure; slightly hard, very friable; slightly acid; abrupt smooth boundary.

Bw1—6 to 11 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; moderate medium prismatic structure parting to moderate medium and fine subangular blocky; hard, friable, slightly sticky and slightly plastic; neutral; clear smooth boundary.

Bw2—11 to 17 inches; brown (10YR 5/3) silty clay loam, dark brown (10YR 4/3) moist; moderate medium prismatic structure parting to moderate medium subangular blocky; hard, friable, slightly sticky and slightly plastic; neutral; abrupt wavy boundary.

BCk—17 to 21 inches; pale brown (10YR 6/3) silty clay loam, brown (10YR 5/3) moist; moderate medium prismatic structure parting to moderate medium subangular blocky; hard, friable, slightly sticky and slightly plastic; few fine accumulations of carbonate; strong effervescence; moderately alkaline; clear wavy boundary.

Ck—21 to 34 inches; light yellowish brown (2.5Y 6/4) silt loam, light olive brown (2.5Y 5/4) moist; massive; hard, friable, slightly sticky and slightly plastic; common fine accumulations of carbonate; strong effervescence; moderately alkaline; gradual wavy boundary.

C—34 to 60 inches; light yellowish brown (2.5Y 6/4) silt loam, light olive brown (2.5Y 5/4) moist; common fine and medium strong brown (7.5YR 5/6) mottles; massive; slightly hard, friable, slightly sticky and slightly plastic; common fine accumulations of carbonate; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 14 to 30 inches. The thickness of the mollic epipedon ranges from 10 to 16 inches. The depth to free carbonates ranges from 12 to 25 inches.

The A horizon has value of 4 or 5 (2 or 3 moist) and chroma of 1 or 2. It dominantly is silt loam but in some pedons is loam. It is 5 to 8 inches thick. It is slightly acid or neutral. The Bw and C horizons are loam, silt loam, clay loam, or silty clay loam. The Bw horizon has hue of 10YR or 2.5Y and value of 4 to 6 (3 to 5 moist). It is neutral or mildly alkaline. The C horizon has hue of 10YR or 2.5Y, value of 5 to 7 (4 or 5 moist), and chroma of 2 to 4. It is mildly alkaline or moderately alkaline. Some pedons do not have a BC horizon.

Cavo Series

The Cavo series consists of deep, moderately well drained soils formed in glacial till on uplands. Permeability is very slow in the subsoil and slow in the underlying material. Slopes range from 0 to 6 percent.

Cavo soils are similar to Niobell and Noonan soils and commonly are near Miranda, Niobell, Noonan, and Raber soils. Niobell soils do not have columnar structure in the Bt horizon. Miranda and Noonan soils contain less clay in the subsoil than the Cavo soils. Also, Miranda soils have visible salts within a depth of 16 inches. They are in slight depressions. Raber soils do not have a natric horizon. They are higher on the landscape than the Cavo soils.

Typical pedon of Cavo loam, in an area of Raber-Cavo complex, 0 to 2 percent slopes, 800 feet north and 525 feet east of the southwest corner of sec. 6, T. 117 N., R. 72 W.

A—0 to 3 inches; gray (10YR 5/1) loam, black (10YR 2/1) moist; weak fine granular structure; slightly hard, very friable; slightly acid; clear smooth boundary.

E—3 to 5 inches; gray (10YR 5/1) loam, very dark grayish brown (10YR 3/2) moist; weak thin platy structure parting to weak fine granular; slightly hard, very friable; neutral; abrupt smooth boundary.

Bt1—5 to 9 inches; grayish brown (2.5Y 5/2) clay, very dark grayish brown (2.5Y 3/2) moist; strong medium columnar structure parting to strong fine and medium blocky; thin continuous gray (10YR 6/1) coatings on the top of the columns; extremely hard, firm, sticky and plastic; mildly alkaline; clear smooth boundary.

Bt2—9 to 12 inches; dark grayish brown (2.5Y 4/2) clay, very dark grayish brown (2.5Y 3/2) moist; moderate medium prismatic structure parting to strong fine and medium blocky; very hard, firm, sticky and plastic; moderately alkaline; abrupt wavy boundary.

BCk—12 to 23 inches; grayish brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) moist; weak coarse prismatic structure parting to moderate medium subangular blocky; very hard, firm, sticky and plastic; few fine accumulations of carbonate; strong effervescence; few fine nests of salts in the lower part; moderately alkaline; clear wavy boundary.

Ck—23 to 30 inches; light brownish gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) moist; few medium prominent yellowish red (5YR 4/6) mottles; moderate medium subangular blocky structure; very hard, firm, sticky and plastic; common fine and medium accumulations of carbonate; strong effervescence; few fine nests of salts; moderately alkaline; gradual wavy boundary.

C—30 to 60 inches; light gray (2.5Y 7/2) clay loam, olive brown (2.5Y 4/4) moist; common medium prominent strong brown (7.5YR 5/8) and distinct gray (10YR 5/1) mottles; massive; hard, firm, slightly sticky and slightly plastic; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 18 to 30 inches. The thickness of the mollic epipedon ranges from 10 to 18 inches. The depth to free carbonates ranges from 10 to 17 inches.

The A horizon has value of 4 or 5 (2 or 3 moist) and chroma of 1 or 2. It is 3 to 5 inches thick. It dominantly is loam but in some pedons is silt loam. It is slightly acid or neutral. The E horizon has value of 5 to 7 (3 or 4 moist) and chroma of 1 or 2. It is 2 to 4 inches thick. It is loam or silt loam. It is slightly acid or neutral. The Bt horizon has hue of 10YR or 2.5Y and chroma of 1 or 2. It is clay loam or clay. The clay content in this horizon averages as low as 35 percent in some pedons and as high as 48 percent in others. The C horizon has hue of 2.5Y or 5Y and value of 5 to 7 (4 or 5 moist). It is clay loam or clay. It is moderately alkaline or strongly alkaline.

Grassna Series

The Grassna series consists of deep, moderately well drained soils formed in silty alluvium in swales on uplands. Permeability is moderate. Slopes range from 0 to 6 percent.

The Grassna soils in this county are taxadjuncts to the Grassna series because they have lower chroma in the A horizon than is defined as the range for the series. This difference, however, does not alter the usefulness or behavior of the soils.

Grassna soils are similar to Arnegard and Bowbells soils and commonly are near Bryant and Tonka soils. Arnegard and Bowbells soils contain more sand throughout than the Grassna soils. Bryant soils have a mollic epipedon that is less than 16 inches thick. They are on the higher parts of the landscape. The poorly drained Tonka soils are in depressions.

Typical pedon of Grassna silt loam, in an area of Bryant-Grassna silt loams, 2 to 6 percent slopes, 2,328 feet north and 483 feet east of the southwest corner of sec. 15, T. 118 N., R. 70 W.

Ap—0 to 7 inches; dark gray (10YR 4/1) silt loam, black (10YR 2/1) moist; moderate fine and medium granular structure; slightly hard, very friable, slightly sticky and slightly plastic; neutral; abrupt smooth boundary.

Bw1—7 to 20 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; weak medium prismatic structure parting to moderate medium and fine subangular blocky; hard, friable, slightly sticky and slightly plastic; neutral; clear wavy boundary.

Bw2—20 to 32 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; faces of peds are very dark gray (10YR 3/1) when moist; moderate medium prismatic structure parting to strong medium and fine subangular blocky; hard, friable, slightly sticky and slightly plastic; neutral; clear wavy boundary.

BC—32 to 38 inches; light olive brown (2.5Y 5/4) silt loam, dark grayish brown (2.5Y 4/2) moist; moderate medium prismatic structure parting to moderate medium and fine subangular blocky; hard, friable, slightly sticky and slightly plastic; neutral; abrupt wavy boundary.

Ck—38 to 47 inches; light yellowish brown (2.5Y 6/4) silt loam, light olive brown (2.5Y 5/4) moist; massive; slightly hard, slightly sticky and slightly plastic; common fine accumulations of carbonate; strong effervescence; moderately alkaline; clear wavy boundary.

C—47 to 60 inches; pale yellow (2.5Y 7/4) silt loam, light olive brown (2.5Y 5/4) moist; common fine and medium distinct strong brown (7.5YR 5/6) and light gray (10YR 6/1) mottles; massive; slightly hard, friable, slightly sticky and slightly plastic; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 24 to 42 inches. The thickness of the mollic epipedon ranges from 18 to 38 inches.

The A horizon has value of 3 or 4 (2 or 3 moist). It dominantly is silt loam but in some pedons is loam or silty clay loam. It is slightly acid or neutral. It is 7 to 10 inches thick. The Bw horizon has value of 4 or 5 (3 or 4 moist) and chroma of 2 or 3. It is loam, silt loam, or silty clay loam. It is neutral or mildly alkaline. Some pedons do not have a BC horizon. The C horizon has value of 5 or 6 moist and chroma of 2 to 4. It dominantly is silt loam, but in some pedons it is coarser or finer textured below a depth of 40 inches. It is mildly alkaline or moderately alkaline.

Harriet Series

The Harriet series consists of deep, poorly drained soils formed in silty and clayey alluvium on flood plains. Permeability is very slow. Slopes are 0 to 1 percent.

Harriet soils are similar to Heil soils and commonly are near Heil, La Prairie, Miranda, Ranslo, and Williams soils. In Heil soils free carbonates are leached below a depth of 18 inches. These soils are in depressions. La Prairie soils contain less clay in the subsoil than the Harriet soils and do not have a natric horizon. They are on terraces. The somewhat poorly drained Miranda soils formed in glacial till on flats and foot slopes near the margin of the flood plains. The somewhat poorly drained Ranslo soils are higher on the flood plains than the Harriet soils. Also, they have a thicker surface layer. Williams soils formed in glacial till and do not have a natric horizon. They are on uplands.

Typical pedon of Harriet silt loam, in an area of Ranslo-Harriet silt loams, 1,500 feet north and 950 feet west of the southeast corner of sec. 27, T. 119 N., R. 66 W.

E—0 to 3 inches; gray (10YR 5/1) silt loam, very dark gray (10YR 3/1) moist; weak medium and thick platy structure; soft, very friable; moderately alkaline; abrupt wavy boundary.

Bt1—3 to 8 inches; dark gray (10YR 4/1) silty clay, very dark gray (10YR 3/1) moist; moderate medium columnar structure parting to strong fine and medium blocky; extremely hard, very firm, sticky and plastic; thin gray (10YR 6/1) coatings on the top of the columns; strongly alkaline; abrupt wavy boundary.

Bt2—8 to 11 inches; gray (10YR 5/1) silty clay, very dark gray (10YR 3/1) moist; moderate medium prismatic structure parting to moderate medium subangular blocky; very hard, very firm, sticky and plastic; strongly alkaline; abrupt wavy boundary.

Cz—11 to 24 inches; olive gray (5Y 5/2) silty clay, very dark gray (5Y 3/1) moist; weak medium subangular blocky structure; very hard, firm, sticky and plastic; common medium nests of salt crystals; violent effervescence; strongly alkaline; clear wavy boundary.

Cky—24 to 42 inches; pale olive (5Y 6/3) silty clay loam, olive (5Y 5/3) moist; massive; slightly hard, firm; common fine nests of gypsum and salt crystals; few fine accumulations of carbonate; violent effervescence; strongly alkaline; gradual wavy boundary.

C—42 to 60 inches; pale olive (5Y 6/3) silty clay loam, olive (5Y 5/3) moist; massive; slightly hard, friable; few medium accumulations of carbonate; strong effervescence; strongly alkaline.

The thickness of the solum ranges from 10 to 24 inches. The depth to salt crystals ranges from 5 to 16 inches. Some pedons have a buried A horizon or strata of coarser textured material below a depth of 30 inches.

Some pedons have an A horizon, which is 1 to 2 inches thick. The E horizon has hue of 10YR or 2.5Y and value of 5 or 6 (2 or 3 moist). It is 1 to 5 inches thick. It dominantly is silt loam but in some pedons is loam or very fine sandy loam. It is neutral to moderately alkaline. The Bt horizon has hue of 10YR or 2.5Y, value of 4 or 5 (2 or 3 moist), and chroma of 1 or 2. It is silty clay, clay loam, or clay. The C horizon has hue of 2.5Y or 5Y, value of 5 to 7 (3 to 5 moist), and chroma of 1 to 3. It is loam, clay loam, silty clay loam, or silty clay.

Heil Series

The Heil series consists of deep, poorly drained soils formed in clayey and loamy alluvium in depressions on uplands. Permeability is very slow. Slopes are 0 to 1 percent.

Heil soils are similar to Harriet soils and commonly are near Harriet, Nishon, Parnell, Tonka, and Williams soils. Harriet soils have free carbonates within a depth of 18 inches. They are on flood plains. Nishon, Parnell, and Tonka soils are in positions on the landscape similar to those of the Heil soils. Nishon soils do not have a mollic epipedon or a natric horizon. The surface layer of Parnell and Tonka soils is thicker than that of the Heil soils. The well drained Williams soils are higher on the landscape than the Heil soils. They do not have a natric horizon.

Typical pedon of Heil silt loam, 1,200 feet west and 110 feet north of the southeast corner of sec. 26, T. 118 N., R. 66 W.

E—0 to 2 inches; gray (10YR 6/1) silt loam, very dark gray (10YR 3/1) moist; moderate fine subangular blocky and weak thin platy structure; slightly hard, friable; neutral; abrupt wavy boundary.

Bt1—2 to 5 inches; dark gray (10YR 4/1) silty clay, very dark gray (10YR 3/1) moist; strong coarse and medium columnar structure parting to strong coarse and medium subangular blocky; light gray (10YR 7/1) coatings on the top of the columns; extremely hard, very firm, sticky and plastic; mildly alkaline; clear smooth boundary.

Bt2—5 to 12 inches; dark gray (10YR 4/1) silty clay, very dark gray (10YR 3/1) moist; moderate coarse and medium prismatic structure parting to strong medium and fine subangular blocky; very hard, very firm, sticky and plastic; mildly alkaline; abrupt wavy boundary.

BCz—12 to 23 inches; dark gray (5Y 4/1) silty clay, very dark gray (5Y 3/1) moist; moderate coarse and medium prismatic structure parting to moderate medium subangular blocky; very hard, firm, sticky and plastic; many fine and medium nests of gypsum and salt crystals; mildly alkaline; gradual wavy boundary.

Czg—23 to 45 inches; dark gray (5Y 4/1) silty clay, very dark gray (5Y 3/1) moist; moderate medium subangular blocky structure; very hard, firm, sticky and plastic; common fine and medium nests of gypsum and salt crystals; slight effervescence; moderately alkaline; gradual wavy boundary.

Ckg—45 to 60 inches; light olive gray (5Y 6/2) clay loam, olive gray (5Y 5/2) moist; common fine and medium prominent strong brown (7.5YR 5/8) mottles; massive; hard, firm, slightly sticky and slightly plastic; common fine accumulations of carbonate; strong effervescence; moderately alkaline.

The depth to free carbonates ranges from 18 to 48 inches. Some pedons have an A horizon, which is 1 to 2 inches thick. The E horizon has hue of 10YR or 2.5Y and value of 4 to 6 (3 or 4 moist). It is 1 to 4 inches thick. It dominantly is silt loam but in some pedons is silty clay loam. The Bt horizon has hue of 10YR, 2.5Y, or 5Y, value of 4 or 5 (3 or 4 moist), and chroma of 1 or 2. It is silty clay or clay. It is mildly alkaline or moderately alkaline. Some pedons do not have a BC horizon. The Cg horizon has hue of 2.5Y or 5Y, value of 4 to 6 (3 to 5 moist), and chroma of 1 to 4. It is clay loam, silty clay loam, or silty clay. It is moderately alkaline or strongly alkaline. Clay loam glacial till is at a depth of 40 to 60 inches in some pedons.

La Prairie Series

The La Prairie series consists of deep, moderately well drained soils formed in loamy and silty alluvium on stream terraces and flood plains. Permeability is moderate. Slopes range from 0 to 3 percent.

La Prairie soils commonly are near Bowdle, Harriet, Lehr, Ranslo, and Williams soils. Bowdle and Lehr soils are underlain by sand and gravel. They are on terraces. The poorly drained Harriet and somewhat poorly drained

Ranslo soils are on flood plains. They have a natric horizon. Williams soils formed in loamy glacial till and have an argillic horizon. They are higher on the landscape than the La Prairie soils.

Typical pedon of La Prairie loam, 1,870 feet north and 168 feet west of the southeast corner of sec. 8, T. 118 N., R. 66 W.

Ap—0 to 6 inches; dark gray (10YR 4/1) loam, very dark gray (10YR 3/1) moist; weak medium subangular blocky structure parting to moderate medium and fine granular; slightly hard, friable; mildly alkaline; abrupt smooth boundary.

A—6 to 15 inches; dark gray (10YR 4/1) loam, very dark gray (10YR 3/1) moist; weak medium subangular blocky structure; slightly hard, very friable; moderately alkaline; clear wavy boundary.

Bw—15 to 23 inches; dark gray (10YR 4/1) silt loam, very dark gray (10YR 3/1) moist; weak coarse prismatic structure parting to weak medium subangular blocky; slightly hard, very friable; slight effervescence; moderately alkaline; clear wavy boundary.

Ck1—23 to 31 inches; grayish brown (10YR 5/2) silt loam, dark brown (10YR 3/3) moist; weak coarse and medium subangular blocky structure; slightly hard, friable; few fine accumulations of carbonate; strong effervescence; moderately alkaline; gradual wavy boundary.

Ck2—31 to 60 inches; grayish brown (2.5Y 5/2) silt loam, dark grayish brown (2.5Y 4/2) moist; massive; slightly hard, friable; common fine accumulations of carbonate; strong effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 20 to 36 inches. The depth to free carbonates ranges from 0 to 25 inches. A buried A horizon is below a depth of 20 inches in some pedons.

The A horizon has value of 3 or 4 (2 or 3 moist). It is 14 to 26 inches thick. It is loam or silt loam. The Bw and C horizons also are loam or silt loam. They are mildly alkaline or moderately alkaline. The Bw horizon has hue of 10YR or 2.5Y, value of 3 to 5 (2 or 3 moist), and chroma of 1 to 3. The C horizon has value of 4 to 6 (3 to 5 moist) and chroma of 1 to 3. Some pedons have strata of sand or clay below a depth of 40 inches.

Lehr Series

The Lehr series consists of somewhat excessively drained soils that are shallow over gravelly material. These soils formed in loamy and gravelly deposits on terraces. Permeability is moderately rapid in the subsoil and rapid in the underlying material. Slopes range from 0 to 6 percent.

Lehr soils are similar to Manning and Wabek soils and commonly are near Bowdle, Manning, and Wabek soils. Bowdle soils are 20 to 40 inches deep over gravelly material. They are on the lower parts of the landscape. Manning soils contain more sand in the subsoil than the Lehr soils. The excessively drained Wabek soils are on the higher convex parts of the landscape. They are 7 to 14 inches deep over gravelly sand.

Typical pedon of Lehr loam, 0 to 3 percent slopes, 2,600 feet west and 350 feet north of the southeast corner of sec. 7, T. 118 N., R. 66 W.

A—0 to 5 inches; dark gray (10YR 4/1) loam, very dark brown (10YR 2/2) moist; weak medium subangular blocky structure parting to weak fine and medium granular; slightly hard, very friable; neutral; abrupt smooth boundary.

Bw1—5 to 9 inches; dark grayish brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; faces of peds are very dark brown (10YR 2/2) when moist; moderate medium prismatic structure parting to moderate medium subangular blocky; hard, friable; neutral; clear wavy boundary.

Bw2—9 to 15 inches; dark grayish brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; moderate medium prismatic structure parting to moderate fine and medium subangular blocky; hard, friable; mildly alkaline; gradual wavy boundary.

2Ck—15 to 26 inches; grayish brown (2.5Y 5/2) gravelly loamy sand, dark grayish brown (2.5Y 4/2) moist; single grain; loose; few fine and medium accumulations of carbonate; violent effervescence; moderately alkaline; gradual smooth boundary.

2C—26 to 60 inches; light brownish gray (2.5Y 6/2) gravelly loamy sand, dark grayish brown (2.5Y 4/2) moist; single grain; loose; strong effervescence; mildly alkaline.

The thickness of the solum, or the depth to gravelly material, ranges from 14 to 20 inches. The thickness of the mollic epipedon ranges from 10 to 16 inches.

The A horizon has value of 4 or 5 (2 or 3 moist) and chroma of 1 or 2. It dominantly is loam but in some pedons is sandy loam. It is 5 to 8 inches thick. The Bw horizon has value of 4 or 5 (3 or 4 moist) and chroma of 2 or 3. It is loam or clay loam. The 2C horizon has hue of 10YR or 2.5Y, value of 5 to 7 (4 or 5 moist), and chroma of 2 to 4.

Manning Series

The Manning series consists of somewhat excessively drained soils that are shallow or moderately deep over gravelly material. These soils formed in loamy sediment over gravelly material. They are on terraces. Permeability is moderately rapid above the gravelly material and very rapid in the gravelly material. Slopes range from 0 to 3 percent.

Manning soils are similar to Lehr soils and commonly are near Bowdle, Lehr, Tally, and Wabek soils. Bowdle and Lehr soils are in positions on the landscape similar to those of the Manning soils. Bowdle soils are well drained. Lehr soils contain more clay in the subsoil than the Manning soils. Tally soils do not have gravelly material within a depth of 40 inches. They are on slight rises and on some ridges. The excessively drained Wabek soils are 7 to 14 inches deep over gravelly material. They are on knolls and ridges.

Typical pedon of Manning sandy loam, 0 to 3 percent slopes, 2,300 feet east and 210 feet south of the northwest corner of sec. 34, T. 119 W., R. 67 N.

Ap—0 to 7 inches; dark grayish brown (10YR 4/2) sandy loam, very dark grayish brown (10YR 3/2) moist; weak medium and fine granular structure; slightly hard, very friable; neutral; abrupt smooth boundary.

Bw1—7 to 11 inches; dark brown (10YR 4/3) sandy loam, very dark grayish brown (10YR 3/2) moist; weak coarse and medium prismatic structure parting to moderate medium subangular blocky; hard, very friable; neutral; clear smooth boundary.

Bw2—11 to 17 inches; dark brown (10YR 4/3) sandy loam, dark brown (10YR 3/3) moist; weak coarse and medium prismatic structure parting to moderate medium subangular blocky; hard, very friable; neutral; clear smooth boundary.

BC—17 to 22 inches; brown (10YR 5/3) loamy sand, olive brown (2.5Y 4/4) moist; weak coarse prismatic structure; slightly hard, very friable; mildly alkaline; abrupt wavy boundary.

2Ck—22 to 28 inches; grayish brown (2.5Y 5/2) gravelly loamy sand, olive brown (2.5Y 4/4) moist; single grain; loose; carbonate coatings on underside of pebbles; strong effervescence; moderately alkaline; clear wavy boundary.

2C—28 to 60 inches; pale brown (10YR 6/3) gravelly sand, brown (10YR 4/3) moist; single grain; loose; slight and strong effervescence; mildly alkaline.

The thickness of the solum ranges from 14 to 26 inches. The thickness of the mollic epipedon ranges from 10 to 16 inches. The depth to free carbonates ranges from 15 to 26 inches. The depth to gravelly material ranges from 18 to 30 inches.

The A horizon has value of 4 or 5 (2 or 3 moist). It is sandy loam, fine sandy loam, or loam. It is 5 to 8 inches thick. The Bw horizon has value of 4 to 6 (3 or 4 moist) and chroma of 2 to 4. It is fine sandy loam, sandy loam, or loam. It is neutral or mildly alkaline. Some pedons do not have a BC horizon. The 2C horizon has value of 5 to 7 (4 to 6 moist) and chroma of 2 to 4.

Manning Variant

The Manning Variant consists of somewhat poorly drained soils formed in gravelly alluvium overlying loamy glacial till. These soils are very shallow over gravelly material. They are adjacent to depressions in the uplands. Permeability is moderately rapid or rapid in the upper part of the soils and slow in the lower part. Slopes range from 0 to 3 percent.

Manning Variant soils are near Bowbells, Parnell, and Williams soils. Bowbells soils formed in loamy alluvium. They are in swales on uplands. The very poorly drained Parnell soils are in depressions. The well drained Williams soils formed in loamy glacial till on uplands.

Typical pedon of Manning Variant loam, 0 to 3 percent slopes, 500 feet north and 1,170 feet east of the southwest corner of sec. 31, T. 120 N., R. 69 W.

A—0 to 4 inches; very dark gray (10YR 3/1) loam, black (10YR 2/1) moist; weak fine granular structure; slightly hard, very friable; mildly alkaline; abrupt smooth boundary.

AC—4 to 10 inches; grayish brown (10YR 5/2) gravelly loamy sand, very dark grayish brown (10YR 3/2) moist; weak coarse subangular blocky structure; loose; mildly alkaline; clear wavy boundary.

Ck—10 to 24 inches; gray (10YR 5/1) and light brownish gray (10YR 6/2) gravelly loamy sand, grayish brown (10YR 5/2) moist; common fine distinct dark yellowish brown (10YR 3/4) mottles; single grain; slightly hard, very friable; common fine accumulations of carbonate; strong effervescence; mildly alkaline; abrupt wavy boundary.

C1—24 to 37 inches; gray (5Y 6/1) gravelly loamy sand, olive gray (5Y 5/2) moist; common fine distinct dark yellowish brown (10YR 3/4) mottles; single grain; slightly hard, very friable; mildly alkaline; strong effervescence; abrupt wavy boundary.

2C2—37 to 60 inches; pale olive (5Y 6/3) clay loam, olive (5Y 5/3) moist; many fine and medium prominent strong brown (7.5YR 5/6) and light gray (5Y 7/1) mottles; massive; hard, firm; common fine and medium nests of gypsum; slight effervescence; mildly alkaline.

The depth to free carbonates ranges from 10 to 24 inches. The depth to loamy glacial till ranges from 28 to 40 inches.

The A horizon has hue of 10YR or 2.5Y, value of 3 or 4 (2 or 3 moist), and chroma of 1 or 2. It dominantly is loam but in some pedons is sandy loam or loamy sand. It is 4 to 8 inches thick. The C horizon has hue of 10YR, 2.5Y, or 5Y, value of 4 to 6 (3 to 5 moist), and chroma of 1 to 3. It is gravelly sand or gravelly loamy sand. It is neutral or mildly alkaline. The 2C horizon has hue of 2.5Y or 5Y, value of 5 to 7 (4 or 5 moist), and chroma of 3 or 4. It is loam, clay loam, silty clay, or clay. It is mildly alkaline or moderately alkaline.

Max Series

The Max series consists of deep, well drained soils formed in loamy glacial till on uplands. Permeability is moderate in the upper part of the soils and moderately slow in the underlying material. Slopes range from 2 to 15 percent.

Max soils are similar to Bryant, Vida, and Williams soils and commonly are near Bryant, Parnell, Tonka, Williams, and Zahl soils. Bryant soils contain more silt and less sand throughout than the Max soils. The very poorly drained Parnell and poorly drained Tonka soils are in depressions. Vida and Williams soils have an argillic horizon. Zahl soils have free carbonates within a depth of 10 inches. They are on the upper convex side slopes and knolls.

Typical pedon of Max loam, in an area of Max-Niobell-Noonan loams, 2 to 6 percent slopes, 980 feet west and 36 feet north of the southeast corner of sec. 35, T. 118 N., R. 66 W.

Ap—0 to 8 inches; dark grayish brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; weak fine and medium granular structure; slightly hard, very friable; neutral; abrupt smooth boundary.

Bw—8 to 14 inches; brown (10YR 4/3) loam, dark brown (10YR 3/3) moist; moderate medium prismatic structure parting to moderate medium subangular blocky; hard, friable; neutral; abrupt wavy boundary.

BCk—14 to 21 inches; light yellowish brown (2.5Y 6/3) loam, olive brown (2.5Y 4/4) moist; weak coarse prismatic structure parting to moderate medium subangular blocky; hard, friable; strong effervescence; moderately alkaline; clear wavy boundary.

Ck—21 to 31 inches; light brownish gray (2.5Y 6/2) loam, light olive brown (2.5Y 5/4) moist; weak coarse prismatic structure parting to moderate medium and coarse subangular blocky; hard, friable; few fine accumulations of carbonate; strong effervescence; moderately alkaline; clear wavy boundary.

C—31 to 60 inches; pale yellow (2.5Y 7/4) loam, olive brown (2.5Y 4/4) moist; few fine and medium distinct strong brown (7.5YR 5/8) mottles; massive; hard, friable; few fine nests of gypsum crystals; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 10 to 22 inches. The thickness of the mollic epipedon ranges from 8 to 16 inches.

The A horizon has value of 4 or 5 (2 or 3 moist) and chroma of 2 or 3. It is 5 to 10 inches thick. It dominantly is loam but in some pedons is clay loam. It is neutral or mildly alkaline. The Bw horizon has hue of 10YR or 2.5Y, value of 4 to 6 (3 or 4 moist), and chroma of 3 or 4. It is neutral or mildly alkaline. Some pedons do not have a BC horizon. The C horizon has hue of 2.5Y or 5Y, value of 5 to 7 (4 or 5 moist), and chroma of 2 to 4. It is loam or clay loam.

Miranda Series

The Miranda series consists of deep, somewhat poorly drained soils formed in loamy glacial till on uplands. Permeability is very slow. Slopes range from 0 to 5 percent.

Miranda soils commonly are near Cavo, Max, Noonan, and Williams soils. Cavo soils contain more clay in the subsoil than the Miranda soils and are more than 16 inches deep to salts and gypsum crystals. They are on slight rises. The well drained Max and Williams soils are on the mid and upper side slopes. They do not have a natric horizon. Noonan soils do not have visible salts within a depth of 16 inches. They are on slight rises.

Typical pedon of Miranda loam, in an area of Noonan-Miranda loams, 0 to 5 percent slopes, 2,500 feet north and 390 feet west of the southeast corner of sec. 19, T. 118 N., R. 66 W.

A—0 to 3 inches; dark gray (10YR 4/1) loam, black (10YR 2/1) moist; weak fine granular structure; slightly hard, very friable; slightly acid; abrupt smooth boundary.

E—3 to 5 inches; gray (10YR 5/1) loam, very dark grayish brown (10YR 3/2) moist; moderate medium subangular blocky structure parting to weak medium platy; slightly hard, very friable; neutral; abrupt smooth boundary.

Bt1—5 to 9 inches; dark grayish brown (10YR 4/2) clay loam, very dark brown (10YR 2/2) moist; strong medium columnar structure; extremely hard, very firm, sticky and plastic; mildly alkaline; abrupt smooth boundary.

Bt2—9 to 13 inches; grayish brown (10YR 5/2) clay loam, very dark grayish brown (10YR 3/2) moist; moderate medium prismatic structure parting to moderate medium subangular blocky; very hard, very firm, sticky and plastic; moderately alkaline; abrupt wavy boundary.

BCz—13 to 20 inches; dark grayish brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; weak medium prismatic structure parting to moderate medium subangular blocky; hard, firm, sticky and plastic; common fine accumulations of salts; strongly alkaline; clear wavy boundary.

Ckz—20 to 26 inches; light olive brown (2.5Y 5/4) clay loam, olive brown (2.5Y 4/4) moist; massive; hard, firm, sticky and plastic; few fine accumulations of carbonate and salts; slight effervescence; strongly alkaline; gradual wavy boundary.

Ck—26 to 42 inches; pale olive (5Y 6/3) clay loam, olive (5Y 5/3) moist; massive; hard, firm, slightly sticky and slightly plastic; common fine and medium accumulations of carbonate; strong effervescence; strongly alkaline; gradual wavy boundary.

C—42 to 60 inches; pale olive (5Y 6/3) clay loam, olive (5Y 5/3) moist; massive; hard, firm, slightly sticky and slightly plastic; strong effervescence; strongly alkaline.

The thickness of the solum ranges from 12 to 22 inches. The depth to free carbonates ranges from 8 to 22 inches. Visible salt crystals are within a depth of 16 inches.

The A horizon has value of 4 or 5 (2 or 3 moist) and chroma of 1 or 2. It is 2 to 3 inches thick. Some pedons do not have an A horizon. The E horizon has hue of 10YR or 2.5Y, value of 5 or 6 (3 or 4 moist), and chroma of 1 or 2. It is 2 to 5 inches thick. It is loam or silt loam. The Bt and C horizons are loam or clay loam. The Bt horizon has hue of 10YR or 2.5Y, value of 4 or 5 (2 or 3 moist), and chroma of 2 to 4. The C horizon has hue of 2.5Y or 5Y, value of 5 to 7 (4 to 6 moist), and chroma of 2 to 4. It is moderately alkaline or strongly alkaline.

Mondamin Series

The Mondamin series consists of deep, well drained and moderately well drained soils formed in silty and clayey sediment on uplands. Permeability is moderately slow or slow. Slopes range from 0 to 6 percent.

Mondamin soils are similar to Raber soils and commonly are near Bowbells, Bryant, Raber, Tonka, and Williams soils. The moderately well drained Bowbells soils formed in loamy glacial till in swales. Bryant soils contain more silt and less clay throughout than the Mondamin soils. Also, they are slightly lower on the landscape. Raber and Williams soils formed in glacial till. They are in positions on the landscape similar to those of the Mondamin soils. The poorly drained Tonka soils are in depressions.

Typical pedon of Mondamin silty clay loam, 0 to 2 percent slopes, 550 feet north and 410 feet west of the southeast corner of sec. 30, T. 118 N., R. 72 W.

Ap—0 to 6 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; moderate fine and medium granular structure; slightly hard, friable, slightly sticky and slightly plastic; slightly acid; abrupt smooth boundary.

Bt—6 to 14 inches; grayish brown (2.5Y 5/2) silty clay, very dark grayish brown (2.5Y 3/2) moist; weak medium prismatic structure parting to moderate fine and medium subangular blocky; very hard, firm, sticky and plastic; common dark grayish brown (10YR 4/2) tongues, very dark brown (10YR 2/2) moist; neutral; abrupt wavy boundary.

BCk1—14 to 19 inches; grayish brown (2.5Y 5/2) silty clay, dark grayish brown (2.5Y 4/2) moist; weak medium prismatic structure parting to moderate medium and fine subangular blocky; very hard, firm, sticky and plastic; common dark grayish brown (10YR 4/2) tongues, very dark brown (10YR 2/2) moist; strong effervescence; mildly alkaline; clear wavy boundary.

BCk2—19 to 27 inches; light brownish gray (2.5Y 6/2) silty clay, dark grayish brown (2.5Y 4/2) moist; weak coarse prismatic structure parting to moderate medium subangular blocky; very hard, firm, sticky and plastic; many fine and medium accumulations of carbonate; strong effervescence; mildly alkaline; gradual wavy boundary.

Ck—27 to 37 inches; light brownish gray (2.5Y 6/2) silty clay loam, grayish brown (2.5Y 5/2) moist; many fine and medium prominent strong brown (7.5YR 5/6 and 5/8) mottles; massive; hard, firm, slightly sticky and slightly plastic; many fine and medium accumulations of carbonate; strong effervescence; moderately alkaline; clear wavy boundary.

Cy—37 to 60 inches; light brownish gray (2.5Y 6/2) silty clay loam, grayish brown (2.5Y 5/2) moist; many fine and medium prominent strong brown (7.5YR 4/6 and 5/8) mottles; massive; hard, friable, slightly sticky and slightly plastic; common medium nests of gypsum crystals; common fine and medium accumulations of carbonate; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 20 to 35 inches. The thickness of the mollic epipedon ranges from 10 to 16 inches. The depth to free carbonates ranges from 12 to 18 inches.

The A horizon has value of 4 or 5 (2 or 3 moist). It dominantly is silty clay loam but in some pedons is silt loam. It is 5 to 8 inches thick. It is slightly acid or neutral. The Bt horizon has hue of 10YR or 2.5Y, value of 4 or 5 (2 or 3 moist), and chroma of 2 or 3. It is silty clay loam or silty clay. The C horizon has value of 5 to 7 (4 or 5 moist) and chroma of 2 or 3. It dominantly is silty clay loam but in some pedons is stratified with thin lenses of silt loam and fine sand. It is mildly alkaline or moderately alkaline. Clay loam glacial till is below a depth of 40 inches in some pedons.

Niobell Series

The Niobell series consists of deep, moderately well drained soils formed in glacial till on uplands. Permeability is slow. Slopes range from 0 to 6 percent.

Niobell soils are similar to Cavo and Noonan soils and commonly are near Bowbells, Cavo, Max, Miranda, Noonan, and Williams soils. Bowbells soils do not have a natric horizon. They are in swales. Cavo and Noonan soils have columnar structure in the Bt horizon. The well drained Max and Williams soils are on side slopes and on broad ridgetops. They do not have a natric horizon. Miranda soils have salts within a depth of 16 inches. They are in small depressions.

Typical pedon of Niobell loam, in an area of Max-Niobell-Noonan loams, 2 to 6 percent slopes, 650 feet south and 500 feet east of the northwest corner of sec. 22, T. 117 N., R. 66 W.

Ap—0 to 7 inches; dark grayish brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; moderate fine and medium granular structure; slightly hard, very friable; slightly acid; abrupt smooth boundary.

BE—7 to 12 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; weak medium prismatic structure parting to moderate fine and medium subangular blocky; hard, very friable; gray (10YR 6/1) silt and sand coatings on faces of peds; neutral; clear wavy boundary.

Bt1—12 to 18 inches; dark grayish brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; moderate medium prismatic structure parting to moderate medium subangular blocky; very hard, firm, sticky and plastic; mildly alkaline; clear wavy boundary.

Bt2—18 to 26 inches; brown (10YR 5/3) clay loam, dark grayish brown (10YR 4/2) moist; moderate medium prismatic structure parting to strong fine and medium subangular blocky; very hard, firm, sticky and plastic; moderately alkaline; abrupt wavy boundary.

Ck1—26 to 34 inches; grayish brown (2.5Y 5/2) loam, dark grayish brown (2.5Y 4/2) moist; weak medium and coarse subangular blocky structure; hard, firm, slightly sticky and slightly plastic; common fine accumulations of carbonate; strong effervescence; strongly alkaline; gradual wavy boundary.

Ck2—34 to 52 inches; light brownish gray (2.5Y 6/3) loam, grayish brown (2.5Y 5/3) moist; massive; hard, firm, slightly sticky and slightly plastic; common fine and medium accumulations of carbonate; strong effervescence; strongly alkaline; gradual wavy boundary.

C—52 to 60 inches; light brownish gray (2.5Y 6/2) loam, dark grayish brown (2.5Y 4/2) moist; common fine strong brown (7.5YR 5/8) mottles; massive; hard, firm, slightly sticky and slightly plastic; strong effervescence; strongly alkaline.

The thickness of the solum ranges from 18 to 36 inches. The depth to free carbonates ranges from 16 to 29 inches.

The A horizon has value of 4 or 5 (2 or 3 moist). It is 6 to 10 inches thick. It dominantly is loam but in some pedons is silt loam. Some pedons have an E horizon. The Bt and C horizons are loam or clay loam. The Bt horizon has hue of 10YR or 2.5Y, value of 4 to 6 (3 or 4 moist), and chroma of 2 to 4. The C horizon has hue of 2.5Y or 5Y, value of 5 to 7 (4 to 6 moist), and chroma of 2 to 4. Some pedons have a BC horizon.

Nishon Series

The Nishon series consists of deep, poorly drained soils formed in local alluvium in depressions on uplands. Permeability is slow. Slopes are 0 to 1 percent.

Nishon soils are similar to Tonka soils and commonly are near Bowbells, Heil, Parnell, Tonka, and Williams soils. The moderately well drained Bowbells soils formed in glacial till. They are in swales. Heil, Parnell, and Tonka soils are in positions on the landscape similar to those of the Nishon soils. Heil soils have a natric horizon. Their surface soil is thinner than that of the Nishon soils. Parnell and Tonka soils have a mollic epipedon. The well drained Williams soils are higher on the landscape than the Nishon soils.

Typical pedon of Nishon silt loam, in an area of Tonka-Nishon silt loams, 1,750 feet south and 800 feet west of the northeast corner of sec. 14, T. 118 N., R. 70 W.

A—0 to 2 inches; dark gray (10YR 4/1) silt loam, black (10YR 2/1) moist; weak fine granular structure; slightly hard, very friable; neutral; clear smooth boundary.

E—2 to 7 inches; light gray (10YR 6/1) silt loam, dark gray (10YR 4/1) moist; few medium distinct brown (10YR 4/3) mottles; moderate thin platy structure; slightly hard, very friable; neutral; abrupt smooth boundary.

Bt1—7 to 10 inches; dark gray (10YR 4/1) silty clay, very dark gray (10YR 3/1) moist; moderate medium and coarse columnar structure parting to strong fine and medium blocky; very hard, very firm, sticky and plastic; neutral; clear wavy boundary.

Bt2—10 to 23 inches; dark gray (5Y 4/1) silty clay, very dark gray (5Y 3/1) moist; moderate coarse and medium prismatic structure parting to strong medium and fine blocky; very firm, very hard, sticky and plastic; neutral; gradual wavy boundary.

BC—23 to 32 inches; dark gray (5Y 4/1) silty clay, very dark gray (5Y 3/1) moist; weak coarse prismatic structure parting to moderate medium blocky; very hard, very firm, sticky and plastic; few medium accumulations of carbonate; mildly alkaline; abrupt wavy boundary.

Ck—32 to 39 inches; light olive gray (5Y 6/2) silty clay loam, olive gray (5Y 4/2) moist; few fine distinct strong brown (7.5YR 5/6) mottles; massive; slightly hard, friable, slightly sticky and slightly plastic; common medium accumulations of carbonate; strong effervescence; moderately alkaline; gradual wavy boundary.

C—39 to 60 inches; light olive gray (5Y 6/2) silty clay loam, olive gray (5Y 4/2) moist; common medium distinct strong brown (7.5YR 5/6) mottles; massive; slightly hard, friable, slightly sticky and slightly plastic; few medium accumulations of carbonate; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 25 to 48 inches. The depth to free carbonates ranges from 18 to 44 inches.

The A horizon has hue of 10YR or 2.5Y and value of 4 or 5 (2 or 3 moist). It dominantly is silt loam but in some pedons is loam or silty clay loam. It is 1 to 2 inches thick. Some pedons do not have an A horizon. The E horizon has hue of 10YR or 2.5Y and value of 5 or 6 (4 or 5 moist). It is loam or silt loam and is 4 to 7 inches thick. It is slightly acid or neutral. In cultivated areas the A and E horizons are mixed. The Bt horizon has hue of 10YR, 2.5Y, or 5Y or is neutral in hue. It has value of 4 or 5 (3 or 4 moist) and chroma of 0 or 1. It is silty clay or clay. It is mildly alkaline or moderately alkaline. In some pedons it does not have columnar structure. The C horizon has hue of 2.5Y or 5Y, value of 4 to 7 (2 to 4 moist), and chroma of 1 to 3. It is silty clay loam, silty clay, or clay loam. It is moderately alkaline or strongly alkaline.

Noonan Series

The Noonan series consists of deep, moderately well drained soils formed in glacial till on uplands. Permeability is slow. Slopes range from 0 to 6 percent.

Noonan soils are similar to Cavo and Niobell soils and commonly are near Cavo, Max, Miranda, Niobell, and Williams soils. Cavo soils contain more clay in the subsoil than the Noonan soils. The well drained Max and Williams soils are on the higher parts of the landscape. They do not have a natric horizon. Miranda soils have visible salts within a depth of 16 inches. They are in small pits and depressions. Niobell soils do not have columnar structure in the Bt horizon.

Typical pedon of Noonan loam, in an area of Max-Niobell-Noonan loams, 2 to 6 percent slopes, 345 feet south and 140 feet west of the northeast corner of sec. 19, T. 118 N., R. 66 W.

Ap—0 to 6 inches; grayish brown (10YR 5/2) loam, very dark brown (10YR 2/2) moist; weak fine granular structure; slightly hard, very friable; neutral; abrupt smooth boundary.

E—6 to 8 inches; light brownish gray (10YR 6/2) loam, very dark grayish brown (10YR 3/2) moist; weak medium subangular blocky structure parting to weak thin platy; slightly hard, friable; neutral; abrupt smooth boundary.

Bt1—8 to 12 inches; brown (10YR 5/3) clay loam, dark brown (10YR 3/3) moist; moderate medium columnar structure parting to strong medium and fine blocky; thin light brownish gray (10YR 6/2) coatings on the top of the columns; extremely hard, very firm, sticky and plastic; mildly alkaline; clear smooth boundary.

Bt2—12 to 19 inches; brown (10YR 5/3) clay loam, dark brown (10YR 3/3) moist; moderate medium prismatic structure parting to moderate medium and fine blocky; very hard, firm, sticky and plastic; mildly alkaline; clear wavy boundary.

BCz—19 to 23 inches; light yellowish brown (10YR 6/4) loam, brown (10YR 4/3) moist; weak coarse prismatic structure parting to moderate medium subangular blocky; hard, friable, slightly sticky and slightly plastic; common fine and medium nests of salts; moderately alkaline; clear wavy boundary.

Cky—23 to 34 inches; light gray (2.5Y 7/2) loam, light olive brown (2.5Y 5/4) moist; massive; hard, friable; few fine nests of gypsum; few fine accumulations of carbonate; strong effervescence; moderately alkaline; gradual wavy boundary.

C—34 to 60 inches; pale yellow (2.5Y 7/4) loam, light yellowish brown (2.5Y 6/4) moist; massive; hard, friable; strong effervescence; strongly alkaline.

The thickness of the solum ranges from 16 to 28 inches. The depth to free carbonates ranges from 12 to 34 inches.

The A horizon has value of 3 to 5 (2 or 3 moist). It dominantly is loam but in some pedons is silt loam. It is 5 to 10 inches thick. The E horizon has hue of 10YR or 2.5Y, value of 5 or 6 (3 or 4 moist), and chroma of 1 or 2. It is loam or silt loam and is 1 to 5 inches thick. In some cultivated areas it is mixed with the Ap horizon. The Bt horizon has hue of 10YR or 2.5Y, value of 4 or 5 (2 or 3 moist), and chroma of 2 or 3. It is mildly alkaline or moderately alklaine. In some pedons the BC horizon is calcareous. The C horizon has hue of 2.5Y or 5Y, value of 5 to 7 (4 to 6 moist), and chroma of 2 to 4. It is loam or clay loam.

Parnell Series

The Parnell series consists of deep, very poorly drained soils formed in alluvium in depressions on uplands. Permeability is slow. Slopes are 0 to 1 percent.

Parnell soils are similar to Tonka soils and commonly are near Bowbells, Max, Tonka, and Williams soils. The moderately well drained Bowbells soils are in swales. The well drained Max and Williams soils are higher on the landscape than the Parnell soils. The poorly drained Tonka soils are in positions on the landscape similar to those of the Parnell soils.

Typical pedon of Parnell silty clay loam, 710 feet south and 160 feet east of the northwest corner of sec. 3, T. 119 N., R. 71 W.

A—0 to 6 inches; dark gray (N 4/0) silty clay loam, black (N 2/0) moist; moderate fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; neutral; clear wavy boundary.

Btg1—6 to 13 inches; dark gray (2.5Y 4/1) silty clay, black (2.5Y 2/1) moist; moderate coarse prismatic structure parting to strong medium and fine blocky; extremely hard, very firm, sticky and plastic; neutral; abrupt wavy boundary.

Btg2—13 to 36 inches; dark gray (2.5Y 4/1) silty clay, black (2.5Y 2/1) moist; moderate coarse prismatic structure parting to strong medium and fine blocky; extremely hard, very firm, sticky and plastic; mildly alkaline; gradual wavy boundary.

BCg—36 to 50 inches; dark gray (2.5Y 4/1) silty clay, black (2.5Y 2/1) moist; weak coarse prismatic structure parting to moderate medium and fine blocky; extremely hard, very firm, sticky and plastic; mildly alkaline; clear wavy boundary.

Ckg—50 to 60 inches; gray (5Y 6/1) clay loam, gray (5Y 5/1) and olive gray (5Y 5/2) moist; common fine and medium distinct dark grayish brown (2.5Y 4/2) and few fine prominent yellowish brown (10YR 5/8) mottles; massive; hard, firm, slightly sticky and slightly plastic; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 35 to 60 inches. The thickness of the mollic epipedon ranges from 30 to 60 inches. The depth to free carbonates ranges from 35 to 55 inches.

The A horizon has hue of 10YR or 2.5Y or is neutral in hue. It has value of 3 or 4 (2 or 3 moist) and chroma of 0 or 1. It dominantly is silty clay loam but in some pedons is silty clay. It is 6 to 12 inches thick. The Btg and C horizons are silty clay, silty clay loam, or clay loam. The Btg horizon has hue of 2.5Y or 5Y, value of 3 or 4 (2 or 3 moist), and chroma of 1 or 2. The C horizon has hue of 2.5Y or 5Y, value of 5 or 6 (4 or 5 moist), and chroma of 1 or 2. It is mildly alkaline or moderately alkaline.

Raber Series

The Raber series consists of deep, well drained soils formed in glacial till on uplands. Permeability is moderately slow or slow. Slopes range from 0 to 6 percent.

Raber soils are similar to Mondamin and Williams soils and commonly are near Cavo, Mondamin, Williams, and Zahill soils. Cavo soils have a natric horizon. They are in small depressions. Mondamin soils contain less sand throughout than the Raber soils. They formed in silty and clayey sediment. Williams soils contain less clay in the subsoil than the Raber soils. Zahill soils do not have a mollic epipedon. They are on knolls and ridges.

Typical pedon of Raber clay loam, in an area of Raber-Cavo complex, 2 to 6 percent slopes, 1,575 feet west and 1,350 feet south of the northeast corner of sec. 6, T. 117 N., R. 72 W.

A—0 to 5 inches; dark gray (10YR 4/1) clay loam, black (10YR 2/1) moist; moderate fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; slightly acid; clear smooth boundary.

Bt—5 to 13 inches; grayish brown (2.5Y 5/2) clay loam, very dark grayish brown (2.5Y 3/2) moist; moderate medium prismatic structure parting to moderate medium subangular blocky; hard, firm, sticky and plastic; common fine tongues, very dark gray (10YR 3/1) moist; neutral; abrupt wavy boundary.

BCk1—13 to 21 inches; light brownish gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) moist; moderate medium prismatic structure parting to moderate medium and fine subangular blocky; hard, firm, sticky and plastic; common fine tongues, very dark gray (10YR 3/1) moist; many fine and medium accumulations of carbonate; strong effervescence; moderately alkaline; gradual wavy boundary.

BCk2—21 to 32 inches; light brownish gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) moist; weak coarse and medium prismatic structure parting to moderate medium and fine subangular blocky; hard, firm, sticky and plastic; common fine and medium accumulations of carbonate; strong effervescence; moderately alkaline; gradual wavy boundary.

C—32 to 60 inches; light gray (2.5Y 7/2) clay loam, grayish brown (2.5Y 5/2) moist; common fine and medium prominent strong brown (7.5YR 5/8) mottles; massive; hard, firm, slightly sticky and slightly plastic; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 24 to 38 inches. The thickness of the mollic epipedon ranges from 8 to 16 inches. The depth to free carbonates ranges from 12 to 18 inches.

The A horizon has value of 4 or 5 (2 or 3 moist) and chroma of 1 or 2. It is 4 to 6 inches thick. It is loam or clay loam. It is slightly acid or neutral. The Bt horizon has hue of 10YR or 2.5Y, value of 4 or 5 (2 or 3 moist), and chroma of 2 or 3. It is neutral or mildly alkaline. It is clay loam or clay. The clay content in this horizon averages as low as 35 percent in some pedons and as high as 45 percent in others. The C horizon has value of 5 to 7 (4 to 6 moist) and chroma of 2 to 4. It is mildly alkaline or moderately alkaline.

Ranslo Series

The Ranslo series consists of deep, somewhat poorly drained soils formed in alluvium on flood plains. Permeability is slow. Slopes are 0 to 1 percent.

Ranslo soils commonly are near Harriet, Heil, La Prairie, and Williams soils. The poorly drained Harriet soils are slightly lower on the flood plains than the Ranslo soils. Also, they have a thinner surface layer. The poorly drained Heil soils are in depressions. Their surface layer is thinner than that of the Ranslo soils. The moderately well drained La Prairie soils are higher on the flood plains than the Ranslo soils. They do not have a natric horizon. The well drained Williams soils are on uplands. They formed in glacial till and do not have a natric horizon.

Typical pedon of Ranslo silt loam, in an area of Ranslo-Harriet silt loams, 2,175 feet west and 800 feet north of the southeast corner of sec. 25, T. 118 N., R. 71 W.

A—0 to 6 inches; dark gray (10YR 4/1) silt loam, black (10YR 2/1) moist; moderate fine and medium granular structure; slightly hard, friable, slightly sticky and slightly plastic; slightly acid; clear wavy boundary.

E—6 to 10 inches; gray (10YR 5/1) silt loam, very dark gray (10YR 3/1) crushing to very dark grayish brown (10YR 3/2) moist; weak fine subangular blocky structure; slightly hard, friable; neutral; abrupt smooth boundary.

Bt1—10 to 15 inches; very dark gray (10YR 3/1) silty clay, black (10YR 2/1) moist; moderate medium prismatic structure parting to strong medium and fine blocky; very hard, firm, sticky and plastic; thin continuous gray (10YR 6/1) coatings on the top of the columns; neutral; abrupt smooth boundary.

Bt2—15 to 20 inches; dark gray (10YR 4/1) silty clay, very dark gray (10YR 3/1) moist; moderate medium prismatic structure parting to strong medium blocky; very hard, firm, sticky and plastic; slight effervescence; moderately alkaline; clear smooth boundary.

Btz—20 to 31 inches; gray (10YR 5/1) silty clay loam, dark gray (10YR 4/1) moist; weak coarse prismatic structure parting to moderate medium blocky; very hard, firm, sticky and plastic; slight effervescence; common fine nests of salts; mildly alkaline; clear wavy boundary.

Cz—31 to 60 inches; gray (5Y 5/1) silty clay loam, dark gray (5Y 4/1) moist; massive; hard, firm, sticky and plastic; common fine nests of salts; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 18 to 38 inches. The thickness of the mollic epipedon ranges from 15 to 35 inches.

The A horizon has value of 4 or 5 (2 or 3 moist). It dominantly is silt loam but in some pedons is loam. It is 4 to 10 inches thick. The E horizon has value of 5 or 6 (3 or 4 moist) and chroma of 1 or 2. It is slightly acid or neutral. Some pedons do not have an E horizon. Some have a BC horizon. The C horizon has hue of 2.5Y or 5Y, value of 5 to 7 (4 to 6 moist), and chroma of 1 or 2. It is clay loam, silty clay loam, or silty clay. It is moderately alkaline or strongly alkaline.

Tally Series

The Tally series consists of deep, well drained soils formed in loamy and sandy glacial outwash on uplands. Permeability is moderately rapid. Slopes range from 0 to 6 percent.

Tally soils commonly are near Bowdle, Bryant, Lehr, Manning, and Williams soils. Bowdle and Lehr soils contain more clay in the subsoil than the Tally soils and are underlain by gravelly material. They are on terraces. Bryant soils contain more silt throughout and less sand between depths of 10 and 40 inches than the Tally soils. Their positions on the landscape are similar to those of the Tally soils. Manning soils have gravelly material 18 to 30 inches from the surface. They are on terraces. Williams soils contain more clay in the subsoil than the Tally soils and have an argillic horizon. They are in positions on the landscape similar to those of the Tally soils.

Typical pedon of Tally fine sandy loam, 2 to 6 percent slopes, 550 feet east and 105 feet south of the northwest corner of sec. 27, T. 119 N., R. 67 W.

A—0 to 8 inches; dark grayish brown (10YR 4/2) fine sandy loam, very dark brown (10YR 2/2) moist; weak fine granular structure; soft, very friable; neutral; abrupt smooth boundary.

Bw1—8 to 15 inches; dark grayish brown (10YR 4/2) sandy loam, very dark grayish brown (10YR 3/2) moist; weak coarse subangular blocky structure; slightly hard, very friable; neutral; clear wavy boundary.

Bw2—15 to 24 inches; grayish brown (10YR 5/2) sandy loam, dark grayish brown (10YR 4/2) moist; weak coarse prismatic structure parting to weak coarse subangular blocky; slightly hard, very friable; neutral; clear wavy boundary.

BC—24 to 30 inches; pale brown (10YR 6/3) sandy loam, dark brown (10YR 4/3) moist; weak very coarse prismatic structure parting to weak medium subangular blocky; slightly hard, very friable; mildly alkaline; abrupt wavy boundary.

Ck—30 to 39 inches; light brownish gray (2.5Y 6/2) loamy sand, grayish brown (2.5Y 5/2) moist; massive; slightly hard, very friable; common fine and medium accumulations of carbonate; violent effervescence; mildly alkaline; clear smooth boundary.

C—39 to 60 inches; pale brown (10YR 6/3) loamy sand, brown (10YR 5/3) moist; massive; slightly hard, very friable; strong effervescence; mildly alkaline.

The thickness of the solum ranges from 13 to 32 inches. The mollic epipedon is 12 to 15 inches thick. The depth to free carbonates ranges from 18 to 30 inches.

The A horizon has value of 3 or 4 (2 or 3 moist). It is 7 to 10 inches thick. It dominantly is fine sandy loam but in some pedons is loam or sandy loam. The Bw horizon has value of 4 or 5 (3 or 4 moist) and chroma of 2 or 3. It is sandy loam or fine sandy loam. It is neutral or mildly alkaline. Some pedons do not have a BC horizon. The C horizon has hue of 10YR or 2.5Y and value of 5 to 7 (4 to 6 moist). It is loamy fine sand, sandy loam, or loamy sand. It is mildly alkaline or moderately alkaline. Loam or clay loam glacial till is below a depth of 40 inches in some pedons.

Tonka Series

The Tonka series consists of deep, poorly drained soils formed in local alluvium in depressions on uplands. Permeability is slow. Slopes are 0 to 1 percent.

Tonka soils are similar to Nishon and Parnell soils and commonly are near Bowbells, Heil, Nishon, Parnell, and Williams soils. The moderately well drained Bowbells soils are in swales. Heil, Nishon, and Parnell soils are in positions on the landscape similar to those of the Tonka soils. Heil soils have a natric horizon. Their surface layer is thinner than that of the Tonka soils. Nishon soils do not have a mollic epipedon. Parnell soils are very poorly drained. The well drained Williams soils are on the higher parts of the landscape.

Typical pedon of Tonka silt loam, in an area of Tonka-Nishon silt loams, 2,180 feet east and 800 feet south of the northwest corner of sec. 25, T. 118 N., R. 67 W.

A—0 to 8 inches; dark gray (10YR 4/1) silt loam, black (10YR 2/1) moist; moderate fine and medium granular structure; soft, very friable; medium acid; abrupt smooth boundary.

E—8 to 21 inches; light gray (2.5Y 7/2) silt loam, grayish brown (2.5Y 5/2) moist; many medium prominent strong brown (7.5YR 5/6) and few medium distinct dark yellowish brown (10YR 3/4) mottles; moderate thin platy structure; slightly hard, very friable; slightly acid; abrupt wavy boundary.

Bt1—21 to 27 inches; dark gray (10YR 4/1) clay, very dark gray (10YR 3/1) moist; strong coarse and medium prismatic structure parting to strong medium and fine blocky; very hard, firm, sticky and plastic; slightly acid; clear wavy boundary.

Bt2—27 to 38 inches; dark gray (10YR 4/1) clay, very dark gray (10YR 3/1) moist; strong coarse and medium prismatic structure parting to strong coarse and medium blocky; very hard, firm, sticky and plastic; neutral; gradual wavy boundary.

BC—38 to 46 inches; gray (5Y 5/1) clay loam, dark gray (5Y 4/1) moist; common medium distinct dark yellowish brown (10YR 4/4) mottles; moderate coarse and medium prismatic structure parting to moderate medium blocky; very hard, firm, sticky and plastic; neutral; abrupt wavy boundary.

Ckg—46 to 60 inches; light olive gray (5Y 6/2) clay loam, olive gray (5Y 5/2) moist; many fine and medium prominent strong brown (7.5YR 5/6) mottles; massive; hard, friable; many medium accumulations of carbonate; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 30 to 50 inches. The depth to free carbonates ranges from 25 to 60 inches.

The A horizon has hue of 10YR, value of 4 or 5 (2 or 3 moist), and chroma of 1. It is 6 to 12 inches thick. It dominantly is silt loam but in some pedons is silty clay loam. It is neutral to medium acid. The E horizon has hue of 10YR or 2.5Y, value of 5 to 7 (3 to 5 moist), and chroma of 1 or 2. It is loam, silt loam, or very fine sandy loam. It is 4 to 16 inches thick. The Bt horizon has hue of 10YR or 2.5Y, value of 4 or 5 (2 to 4 moist), and chroma of 1 or 2. It is clay loam, clay, or silty clay. The C horizon has value of 5 or 6 (4 or 5 moist) and chroma of 1 or 2. It is loam or clay loam and is mildly alkaline or moderately alkaline.

Vida Series

The Vida series consists of deep, well drained soils formed in loamy glacial till on uplands. Permeability is moderate in the solum and moderately slow in the underlying material. Slopes range from 2 to 9 percent.

Vida soils are similar to Max and Williams soils and commonly are near Bowbells, Williams, and Zahl soils. The moderately well drained Bowbells soils are in swales. They have a mollic epipedon that is more than 16 inches thick. Max soils do not have an argillic horizon. Williams soils are deeper to free carbonates than the Vida soils and have a thicker subsoil. They are in positions on the landscape similar to those of the Vida soils. Zahl soils do not have an argillic horizon. They are on the steeper parts of the landscape.

Typical pedon of Vida loam, in an area of Williams-Bowbells-Vida loams, 1 to 6 percent slopes, 850 feet north and 121 feet west of the southeast corner of sec. 15, T. 120 N., R. 72 W.

Ap—0 to 6 inches; dark grayish brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; moderate fine and medium granular structure; slightly hard, friable, slightly sticky and slightly plastic; neutral; abrupt smooth boundary.

Bt—6 to 9 inches; brown (10YR 5/3) clay loam, dark brown (10YR 3/3) moist; moderate medium prismatic structure parting to moderate fine and medium subangular blocky; hard, firm, slightly sticky and slightly plastic; coatings on faces of peds, very dark brown (10YR 2/2) moist; neutral; abrupt wavy boundary.

BCk—9 to 18 inches; light brownish gray (2.5Y 6/2) clay loam, grayish brown (2.5Y 5/2) moist; weak medium and coarse prismatic structure parting to moderate medium subangular blocky; hard, firm, slightly sticky and slightly plastic; common fine and medium accumulations of carbonate; strong effervescence; mildly alkaline; clear wavy boundary.

Ck—18 to 28 inches; light brownish gray (2.5Y 6/2) loam, dark grayish brown (2.5Y 4/2) moist; common fine and medium distinct strong brown (7.5YR 5/6) and gray (10YR 5/1) mottles; massive; hard, friable, slightly sticky and slightly plastic; common fine and medium accumulations of carbonate; strong effervescence; moderately alkaline; gradual wavy boundary.

C—28 to 60 inches; light brownish gray (2.5Y 6/2) loam, dark grayish brown (2.5Y 4/2) moist; common fine and medium distinct strong brown (7.5YR 5/6) and gray (10YR 5/1) mottles; massive; hard, friable, slightly sticky and slightly plastic; common fine accumulations of carbonate; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 15 to 25 inches. The mollic epipedon is 7 to 10 inches thick and in some pedons includes part or all of the Bt horizon. The depth to free carbonates ranges from 6 to 10 inches.

The A horizon has value of 3 or 4 (2 or 3 moist). It is loam, stony loam, very stony loam, or clay loam and is 3 to 7 inches thick. It is neutral or mildly alkaline. The Bt horizon also is neutral or mildly alkaline. It has value of 4 or 5 (3 or 4 moist) and chroma of 2 or 3. The C horizon has value of 6 or 7 (4 or 5 moist) and chroma of 2 to 4. It is loam or clay loam. It is mildly alkaline or moderately alkaline.

Wabek Series

The Wabek series consists of excessively drained soils on outwash plains and terraces. These soils are very shallow or shallow over gravelly material. They formed in glacial outwash. Permeability is very rapid. Slopes range from 3 to 25 percent.

Wabek soils are similar to Lehr soils and commonly are near Bowdle, Lehr, and Manning soils. The adjacent soils are deeper to gravelly material than the Wabek soils. Also, they are lower on the landscape. Bowdle soils are well drained, and Lehr and Manning soils are somewhat excessively drained.

Typical pedon of Wabek loam, 9 to 25 percent slopes, 1,350 feet west and 700 feet south of the northeast corner of sec. 30, T. 119 N., R. 67 W.

A—0 to 8 inches; dark grayish brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; weak fine granular structure; slightly hard, very friable; neutral; clear wavy boundary.

2Ck—8 to 14 inches; dark grayish brown (10YR 4/2) gravelly sandy loam, very dark grayish brown (10YR 3/2) moist; massive; slightly hard, very friable; thin coatings of carbonate on pebbles; strong effervescence; mildly alkaline; clear wavy boundary.

2C1—14 to 23 inches; grayish brown (10YR 5/2) stratified sand and gravel, dark grayish brown (10YR 4/2) moist; single grain; loose; strong effervescence; mildly alkaline; clear wavy boundary.

2C2—23 to 60 inches; light brownish gray (10YR 6/2) stratified sand and gravel, brown (10YR 4/3) moist; single grain; loose; strong effervescence; mildly alkaline.

The depth to gravelly material ranges from 7 to 14 inches. The depth to free carbonates ranges from 5 to 9 inches.

The A horizon has value of 4 or 5 (2 or 3 moist). It is 4 to 8 inches thick. It dominantly is loam but in some pedons is sandy loam or gravelly sandy loam. It is neutral or mildly alkaline.

Williams Series

The Williams series consists of deep, well drained soils formed in loamy glacial till on uplands. Peremability is moderate in the subsoil and moderately slow in the underlying material. Slopes range from 0 to 15 percent.

Williams soils are similar to Max, Raber, and Vida soils and commonly are near Bowbells, Noonan, Tonka, Vida, and Zahl soils. The moderately well drained Bowbells soils are in swales. They are dark to a depth of more than 16 inches. Max soils do not have an argillic horizon. Noonan soils have a natric horizon. They are in small depressions. Raber soils contain more clay in the subsoil than the Williams soils. The poorly drained Tonka soils are in depressions. Vida and Zahl soils have free carbonates within a depth of 10 inches. They are in positions on the landscape similar to those of the Williams soils.

Typical pedon of Williams loam, in an area of Williams-Bowbells loams, 0 to 3 percent slopes, 660 feet north and 132 feet west of the southeast corner of sec. 9, T. 120 N., R. 70 W.

A—0 to 7 inches; dark grayish brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; weak medium and fine granular structure; slightly hard, friable; neutral; abrupt smooth boundary.

Bt1—7 to 12 inches; dark grayish brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; moderate medium prismatic structure parting to strong medium and fine subangular blocky; hard, firm, sticky and plastic; shiny films on faces of peds; neutral; clear wavy boundary.

Bt2—12 to 18 inches; brown (10YR 5/3) clay loam, dark brown (10YR 3/3) crushing to brown (10YR 4/3) moist; moderate medium prismatic structure parting to strong medium and fine subangular blocky; hard, firm, sticky and plastic; shiny films on faces of peds; neutral; abrupt wavy boundary.

BCk—18 to 30 inches; light olive brown (2.5Y 5/4) clay loam, olive brown (2.5Y 4/4) moist; moderate coarse prismatic structure parting to moderate coarse and medium subangular blocky; hard, friable, slightly sticky and slightly plastic; common fine and medium accumulations of carbonate; slight effervescence; mildly alkaline; gradual wavy boundary.

Ck—30 to 38 inches; pale yellow (2.5Y 7/4) clay loam, light yellowish brown (2.5Y 6/4) moist; common fine and medium distinct strong brown (7.5YR 5/8) mottles; massive; hard, friable, slightly sticky and slightly plastic; common fine accumulations of carbonate; strong effervescence; moderately alkaline; gradual wavy boundary.

C—38 to 60 inches; pale yellow (2.5Y 7/4) clay loam, light yellowish brown (2.5Y 6/4) moist; common fine and medium distinct strong brown (7.5YR 5/8) mottles; massive; hard, friable, slightly sticky and slightly plastic; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 15 to 30 inches. The thickness of the mollic epipedon ranges from 10 to 16 inches. The depth to free carbonates ranges from 10 to 24 inches.

The A horizon has value of 3 or 4 (2 or 3 moist). It is loam, stony loam, very stony loam, silt loam, or clay loam and is 4 to 9 inches thick. The Bt horizon has hue of 10YR or 2.5Y, value of 4 or 5 (3 or 4 moist), and chroma of 2 or 3. It is loam or clay loam and is neutral or mildly alkaline. Some pedons do not have a BC horizon. The C horizon has hue of 2.5Y or 5Y, value of 6 or 7 (4 to 6 moist), and chroma of 2 to 4. It is loam or clay loam.

Zahill Series

The Zahill series consists of deep, well drained soils formed in loamy glacial till on ridges in the uplands. Permeability is moderately slow. Slopes range from 6 to 40 percent.

Zahill soils are similar to Zahl soils and commonly are near Vida, Williams, and Zahl soils. Vida and Williams soils are lower on the landscape than the Zahill soils. Also, they have a thicker surface layer and have an argillic horizon. Zahl soils have a mollic epipedon. They are in positions on the landscape similar to those of the Zahill soils.

Typical pedon of Zahill loam, in an area of Williams-Zahill-Bowbells loams, 2 to 15 percent slopes, 2,000 feet south and 180 feet east of the northwest corner of sec. 27, T. 117 N., R. 72 W.

A—0 to 3 inches; dark grayish brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; moderate fine and medium granular structure; slightly hard, friable; slight effervescence; moderately alkaline; abrupt smooth boundary.

Ck—3 to 21 inches; grayish brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) moist; common medium distinct strong brown (7.5YR 5/8) and dark olive (5Y 3/4) mottles; weak coarse prismatic structure parting to moderate fine and medium subangular blocky; hard, firm; many fine and medium accumulations of carbonate; violent effervescence; moderately alkaline; gradual wavy boundary.

C1—21 to 45 inches; light brownish gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) moist; common medium distinct strong brown (7.5YR 5/8) and dark olive (5Y 3/4) mottles; massive; hard, friable; strong effervescence; moderately alkaline; gradual wavy boundary.

C2—45 to 60 inches; light brownish gray (2.5Y 6/2) clay loam, olive brown (2.5Y 4/4) moist; common fine distinct strong brown (7.5YR 5/8) mottles; massive; hard, friable; strong effervescence; moderately alkaline.

Free carbonates typically are throughout the profile. In some areas that support native grass, however, the upper few inches are leached of carbonates. Reaction is mildly alkaline or moderately alkaline throughout the profile.

The A horizon has value of 4 or 5 (3 to 5 moist) and chroma of 2 or 3. It is 2 to 5 inches thick. It is loam, very stony loam, or clay loam. The C horizon has value of 5 or 6 (4 or 5 moist). It is loam or clay loam.

Zahl Series

The Zahl series consists of deep, well drained soils formed in loamy glacial till on uplands. Permeability is moderate in the surface layer and moderately slow in the underlying material. Slopes range from 3 to 20 percent.

Zahl soils are similar to Zahill soils and commonly are near Max, Vida, Williams, and Zahill soils. Max and Williams soils are deeper to free carbonates than the Zahl soils. They are on the mid side slopes. Vida soils have an argillic horizon. They are on the upper side slopes. Zahill soils do not have a mollic epipedon.

Typical pedon of Zahl loam, in an area of Max-Arnegard-Zahl loams, 1 to 6 percent slopes, 2,000 feet north and 450 feet west of the southeast corner of sec. 26, T. 118 N., R. 66 W.

Ap—0 to 6 inches; grayish brown (10YR 5/2) loam, very dark brown (10YR 2/2) moist; weak fine granular structure; slightly hard, very friable; slight effervescence; mildly alkaline; abrupt smooth boundary.

Ck1—6 to 19 inches; grayish brown (2.5Y 5/2) loam, dark grayish brown (2.5Y 4/2) moist; weak coarse prismatic structure parting to weak coarse and medium subangular blocky; hard, friable; common fine and medium accumulations of carbonate; strong effervescence; moderately alkaline; clear wavy boundary.

Ck2—19 to 29 inches; light brownish gray (2.5Y 6/2) loam, dark grayish brown (2.5Y 4/2) moist; weak coarse subangular blocky structure; hard, friable; few fine and medium accumulations of carbonate; strong effervescence; moderately alkaline; clear wavy boundary.

Ck3—29 to 60 inches; pale yellow (2.5Y 7/4) loam, light olive brown (2.5Y 5/4) moist; common medium distinct yellowish brown (10YR 5/8) mottles; massive; hard, friable; few medium nests of gypsum; common fine and medium accumulations of carbonate; strong effervescence; moderately alkaline.

Free carbonates are within a depth of 10 inches. The A horizon has hue of 10YR or 2.5Y and value of 3 to 5 (2 or 3 moist). It dominantly is loam but in some pedons is clay loam. It is 5 to 8 inches thick. It is neutral or mildly alkaline. The C horizon has hue of 2.5Y or 5Y, value of 5 to 7 (4 to 6 moist), and chroma of 2 to 4. It is loam or clay loam. It is mildly alkaline or moderately alkaline.

Formation of the Soils

Soil forms when chemical and physical processes act on geologically deposited or accumulated material. The characteristics of the soil at any given point are determined by the physical and mineralogical composition of the parent material, the climate under which the soil material has accumulated and existed since accumulation, the plant and animal life on and in the soil, the relief, and the length of time that the forces of soil formation have acted on the soil material.

Climate and plant and animal life, chiefly plants, are active factors of soil formation. They act on the parent material and slowly change it to a natural body that has genetically related horizons. The effects of climate and plant and animal life are conditioned by relief. The parent material affects the kind of soil profile that forms and, in extreme cases, determines it almost entirely. Finally, time is needed for changing the parent material into a soil having genetically related horizons. Usually, a long time is required for development of distinct horizons.

The factors of soil formation are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effect of any one factor unless conditions are specified for the other four. The following paragraphs relate the factors of soil formation to the soils in Faulk County.

Climate

Climate directly influences the rate of chemical and physical weathering. Faulk County has a continental climate marked by cold winters and hot summers. This climate favors the growth of grasses and the resulting accumulation of organic matter in the upper part of the soil. The precipitation is sufficient to leach carbonates in most soils to an average depth of about 16 inches. The climate generally is uniform throughout the county and thus as a separate factor does not differentiate the soils within the county. Additional climatic data are given under the heading "General Nature of the County."

Plant and Animal Life

Plants, animals, insects, earthworms, bacteria, and fungi have an important effect on soil formation. They cause gains in organic matter, gains or losses in plant nutrients, and changes in soil structure and porosity. In Faulk County the tall and mid prairie grasses have had more influence than other living organisms on soil formation. As a result of these grasses, the surface layer of many soils has a moderate or high content of organic matter. Bowbells soils are an example.

Earthworms, insects, and burrowing animals help to keep the soil open and porous. Bacteria and fungi decompose plant residue, thus releasing plant nutrients.

Parent Material

Most of the soils in Faulk County formed in glacial material derived from preglacial formations of gneiss, granite, limestone, sandstone, siltstone, and shale. The glacier ground up and mixed this material. The resultant mass is an aggregate of sand, silt, clay, and some rock fragments.

The county is in two physiographic regions. The eastern part is in the drift prairie portion of the James Basin, and the central and western parts are on the Coteau du Missouri.

The Coteau du Missouri generally is undulating to hilly and has a poorly defined drainage pattern and many potholes and sloughs. In some areas as much as 250 feet of glacial till overlies shale bedrock. During glaciation the glacial ice in this region had a thick overburden of "superglacial till." The resulting landforms are characteristic of glacial stagnation (*5*). Examples are dead-ice moraines; formerly ice-walled lake plains; circular disintegration ridges, which have the appearance of doughnuts on aerial photos; and gravelly ridges of collapsed stream alluvium. A rolling and hilly dead-ice moraine formed when the glacial ice beneath the superglacial till melted. Vida, Williams, and Zahill are typical of the soils that formed on this landscape. Many depressional soils, such as Parnell and Tonka, also formed on this landscape.

As the ice melted, streams formed on the superglacial till and along the margin of the glacier. These streams deposited coarse material along the channels. Bowdle, Lehr, Manning, and Wabek soils formed in this gravelly superglacial stream alluvium.

Ice-walled lake plains formed where a superglacial stream terminated in a lake. The finer textured material settled in the lake, and after a time the sediments became very thick. As the glacial ice melted, a formation resembling a mesa remained. The formerly ice-walled lake plains are higher than the surrounding landscape. Bryant and Mondamin soils formed in these sediments.

Niobell and Noonan soils formed in glacial till having a high content of salts. Bowbells and Williams soils also formed partly or entirely in glacial till, but they have not been affected by saline ground water.

Bowbells, Parnell, and Tonka are examples of soils that formed partly or entirely in local alluvium washed in from the more sloping adjacent uplands. Harriet, La Prairie, and Ranslo soils formed in alluvium deposited by streams.

Relief

Relief affects soil formation through its effect on drainage, runoff, erosion, plant cover, and soil temperature. On the steeper soils, such as Zahill soils, much of the rainfall runs off the surface. As a result of the excessive runoff, a limited amount of moisture penetrates the surface. Much of the surface soil is lost through erosion. As a result, these soils have a thin surface layer and are calcareous at or near the surface. Runoff is slower on Bryant and Williams soils than on the Zahill soils. As a result, more moisture penetrates the surface and the layers in which organic matter accumulates are thicker. Also, calcium carbonate is leached to a depth of more than 10 inches.

Bowbells and Grassna soils are in swales that receive extra moisture in the form of runoff from adjacent soils. The layers in which organic matter accumulates are thicker than those in the Bryant and Williams soils. Also, calcium carbonate is leached to a greater depth. The seasonal high water table in Harriet and other soils that are in areas where drainage is impeded favors the concentration of salts.

Time

The length of time that the climate, plant and animal life, and relief have affected the parent material helps to determine the kind of soil that forms. All of the soils in Faulk County are young. The youngest are those on active flood plains, such as La Prairie soils.

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Glossary

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Argillic horizon. A subsoil horizon characterized by an accumulation of illuvial clay.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	more than 12

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Boulders. Rock fragments larger than 2 feet (60 centimeters) in diameter.

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Chiseling. Tillage with an implement having one or more soil-penetrating points that shatter or loosen hard compacted layers to a depth below normal plow depth.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Claypan. A slowly permeable soil horizon that contains much more clay than the horizons above it. A claypan is commonly hard when dry and plastic or stiff when wet.

Complex, soil. A map unit of two or more kinds of soil in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils are somewhat similar in all areas.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Contour farming. Growing crops in rows or strips that follow the contour.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Deferred grazing. Postponing grazing or resting grazing land for a prescribed period.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Eluviation. The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material through eluviation are eluvial; those that have received material are illuvial.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes the surface.

Excess fines (in tables). Excess silt and clay in the soil. The soil is not a source of gravel or sand for construction purposes.

Fallow. Cropland left idle in order to restore productivity through accumulation of moisture. Summer fallow is common in regions of limited rainfall where cereal grains are grown. The soil is tilled for at least one growing season for weed control and decomposition of plant residue.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Forb. Any herbaceous plant not a grass or a sedge.

Frost action (in tables). Freezing and thawing of soil moisture. Frost action can damage roads, buildings and other structures, and plant roots.

Glacial outwash (geology). Gravel, sand, and silt, commonly stratified, deposited by glacial melt water.

Glacial till (geology). Unsorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.

Green manure crop (agronomy). A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an uppercase letter represents the major horizons. Numbers or lowercase letters that follow represent subdivisions of the major horizons. The major horizons are as follows:

O horizon.—An organic layer of fresh and decaying plant residue.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, any plowed or disturbed surface layer.

E horizon.—The mineral horizon in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these.

B horizon.—The mineral horizon below an O, A, or E horizon. The B horizon is in part a layer of transition from the overlying horizon to the underlying C horizon. The B horizon also has distinctive characteristics such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) granular, prismatic, or blocky structuure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the overlying horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, an Arabic numeral, commonly a 2, precedes the letter C.

Cr horizon.—Soft, consolidated bedrock beneath the soil.

R layer.—Hard, consolidated bedrock beneath the soil. The bedrock commonly underlies a C horizon, but can be directly below an A or a B horizon.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Illuviation. The movement of soil material from one horizon to another in the soil profile. Generally, material is removed from an upper horizon and deposited in a lower horizon.

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are—

Border.—Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.

Basin.—Water is applied rapidly to nearly level plains surrounded by levees or dikes.

Controlled flooding.—Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.

Corrugation.—Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards so that it flows in only one direction.

Drip (or trickle).—Water is applied slowly and under low pressure to the surface of the soil or into the soil through such applicators as emitters, porous tubing, or perforated pipe.

Furrow.—Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.

Sprinkler.—Water is sprayed over the soil surface through pipes or nozzles from a pressure system.

Subirrigation.—Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.

Wild flooding.—Water, released at high points, is allowed to flow onto an area without controlled distribution.

Large stones (in tables). Rock fragments 3 inches (7.6 centimeters) or more across. Large stones adversely affect the specified use of the soil.

Leaching. The removal of soluble material from soil or other material by percolating water.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Low strength. The soil is not strong enough to support loads.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Mollic epipedon. A thick, dark, humus-rich surface horizon (or horizons) that has high base saturation and pedogenic soil structure. It may include part of the subsoil.

Moraine (geology). An accumulation of earth, stones, and other debris deposited by a glacier. Some types are terminal, lateral, medial, and ground.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent.* The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Natric horizon. A special kind of argillic horizon that contains enough exchangeable sodium to have an adverse effect on the physical condition of the subsoil.

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

Nutrient, plant. Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

Outwash, glacial. Stratified sand and gravel produced by glaciers and carried, sorted, and deposited by glacial melt water.

Outwash plain. A landform of mainly sandy or coarse textured material of glaciofluvial origin. An outwash plain is commonly smooth; where pitted, it is generally low in relief.

Parent material. The unconsolidated organic and mineral material in which soil forms.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percs slowly (in tables). The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.2 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Phase, soil. A subdivision of a soil series based on features that affect its use and management. For example, slope, stoniness, and thickness.

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Ponding. Standing water on soils in closed depressions. Unless the soils are artificially drained, the water can be removed only by percolation or evapotranspiration.

Poor filter (in tables). Because of rapid permeability the soil may not adequately filter effluent from a waste disposal system.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Rangeland. Land on which the potential natural vegetation is predominantly grasses, grasslike plants, forbs, or shrubs suitable for grazing or browsing. It includes natural grasslands, savannas, many wetlands, some deserts, tundras, and areas that support certain forb and shrub communities.

Range condition. The present composition of the plant community on a range site in relation to the potential natural plant community for that site. Range condition is expressed as excellent, good, fair, or poor, on the basis of how much the present plant community has departed from the potential. *Excellent* indicates that more than 75 percent of the present plant community is the potential natural plant community; *good*, 50 to 75 percent; *fair*, 25 to 50 percent; *poor*, less than 25 percent.

Range site. An area of rangeland where climate, soil, and relief are sufficiently uniform to produce a distinct natural plant community. A range site is the product of all the environmental factors responsible for its development. It is typified by an association of species that differ from those on other range sites in kind or proportion of species or total production.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH
Extremely acid	below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sandstone. Sedimentary rock containing dominantly sand-size particles.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the underlying material. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Shale. Sedimentary rock formed by the hardening of a clay deposit.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Siltstone. Sedimentary rock made up of dominantly silt-sized particles.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance. The slope classes recognized in this survey are—

	Percent
Level	0 to 1
Nearly level	0 to 3
Gently sloping or undulating	3 to 6
Moderately sloping or gently rolling	6 to 9
Strongly sloping or rolling	9 to 15
Moderately steep	15 to 25
Steep	25 to 40

Slope (in tables). Slope is great enough that special practices are required to insure satisfactory performance of the soil for a specific use.

Small stones (in tables). Rock fragments less than 3 inches (7.6 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows:

	Millimeters
Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A, E, and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant and animal activities are largely confined to the solum.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter if rounded and 6 to 15 inches (15 to 38 centimeters) in length if flat.

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Stripcropping. Growing crops in a systematic arrangement of strips or bands which provide vegetative barriers to wind and water erosion.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grain* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Subsoiling. Breaking up a compact subsoil by pulling a special chisel through the soil.

Subsurface layer. Any surface soil horizon (A, E, AB, or EB) below the surface layer.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Surface soil. The A, E, AB, and EB horizons. Includes all subdivisions of these horizons.

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that water soaks into the soil or flows slowly to a prepared outlet.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer (in tables). Otherwise suitable soil material too thin for the specified use.

Till plain. An extensive flat to undulating area underlain by glacial till.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Variant, soil. A soil having properties sufficiently different from those of other known soils to justify a new series name, but occurring in such a limited geographic area that creation of a new series is not justified.

Tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

[Data were recorded in the period 1951-78 at Faulkton, S. Dak.]

Month	Temperature						Precipitation				
	Average daily maximum	Average daily minimum	Average	2 years in 10 will have--		Average number of growing degree days*	Average	2 years in 10 will have--		Average number of days with 0.10 inch or more	Average snowfall
				Maximum temperature higher than--	Minimum temperature lower than--			Less than--	More than--		
	°F	°F	°F	°F	°F	Units	In	In	In		In
January----	22.4	0.3	11.4	50	-30	0	0.32	0.10	0.50	1	3.7
February---	29.8	7.5	18.7	58	-27	20	.53	.17	.82	2	7.5
March------	40.6	17.8	29.2	74	-14	79	.90	.16	1.46	2	3.5
April------	58.2	32.5	45.4	89	10	210	2.11	.96	3.11	5	2.0
May--------	71.2	43.2	57.2	93	22	533	2.92	1.30	4.29	6	.0
June-------	80.2	53.5	66.9	98	35	807	3.60	2.05	4.97	7	.0
July-------	87.6	58.1	72.9	105	41	1,020	2.21	.99	3.24	5	.0
August-----	87.1	56.4	71.8	104	39	986	2.11	.98	3.08	4	.0
September--	76.2	45.5	60.9	100	24	627	1.24	.30	2.00	3	.0
October----	64.0	34.8	49.4	91	12	308	1.12	.25	1.80	3	.8
November---	43.6	20.1	31.9	73	-11	33	.57	.08	.94	2	3.5
December---	28.4	7.7	18.1	57	-24	17	.38	.14	.58	2	5.0
Yearly:											
Average--	57.4	31.5	44.5	---	---	---	---	---	---	---	---
Extreme--	---	---	---	107	-31	---	---	---	---	---	---
Total----	---	---	---	---	---	4,640	18.01	13.90	21.86	42	26.0

* A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (40° F).

TABLE 2.--FREEZE DATES IN SPRING AND FALL

[Data were recorded in the period 1951-78 at Faulkton, S. Dak.]

Probability	Temperature		
	24° F or lower	28° F or lower	32° F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	May 13	May 22	June 3
2 years in 10 later than--	May 7	May 17	May 29
5 years in 10 later than--	April 25	May 7	May 18
First freezing temperature in fall:			
1 year in 10 earlier than--	September 26	September 16	September 8
2 years in 10 earlier than--	October 1	September 21	September 12
5 years in 10 earlier than--	October 11	September 30	September 19

TABLE 3.--GROWING SEASON

[Data were recorded in the period 1951-78 at Faulkton, S. Dak.]

Probability	Daily minimum temperature		
	Higher than 24° F	Higher than 28° F	Higher than 32° F
	Days	Days	Days
9 years in 10	149	126	104
8 years in 10	155	133	111
5 years in 10	167	145	123
2 years in 10	179	158	136
1 year in 10	186	164	143

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
Bb	Bowbells loam	4,615	0.7
BoA	Bowdle loam, 0 to 3 percent slopes	3,760	0.6
BrA	Bryant-Grassna silt loams, 0 to 2 percent slopes	6,260	1.0
BrB	Bryant-Grassna silt loams, 2 to 6 percent slopes	4,700	0.7
Ha	Harriet silt loam	4,200	0.7
He	Heil silt loam	7,400	1.2
La	La Prairie loam	4,685	0.7
Lb	La Prairie loam, channeled	3,460	0.5
LeA	Lehr loam, 0 to 3 percent slopes	2,475	0.4
LeB	Lehr loam, 3 to 6 percent slopes	1,580	0.2
MaA	Manning sandy loam, 0 to 3 percent slopes	1,365	0.2
MbA	Manning Variant loam, 0 to 3 percent slopes	270	*
MdA	Max-Arnegard loams, 0 to 3 percent slopes	12,040	1.9
MmB	Max-Arnegard-Zahl loams, 1 to 6 percent slopes	29,260	4.6
MnB	Max-Niobell-Noonan loams, 2 to 6 percent slopes	16,020	2.5
MoA	Mondamin silty clay loam, 0 to 2 percent slopes	1,815	0.3
MoB	Mondamin silty clay loam, 2 to 6 percent slopes	930	0.1
NaA	Niobell-Noonan loams, 0 to 3 percent slopes	4,290	0.7
NbA	Niobell-Noonan-Max loams, 0 to 3 percent slopes	9,490	1.5
Nn	Nishon silt loam	10,685	1.7
NoA	Noonan-Miranda loams, 0 to 5 percent slopes	10,700	1.7
Pa	Parnell silty clay loam	20,820	3.3
Pp	Parnell silty clay loam, ponded	2,220	0.3
Pt	Pits, gravel	570	0.1
RaA	Raber-Cavo complex, 0 to 2 percent slopes	3,035	0.5
RaB	Raber-Cavo complex, 2 to 6 percent slopes	1,360	0.2
Rh	Ranslo-Harriet silt loams	12,310	1.9
TaA	Tally fine sandy loam, 0 to 2 percent slopes	1,045	0.2
TaB	Tally fine sandy loam, 2 to 6 percent slopes	355	0.1
Tn	Tonka-Nishon silt loams	28,920	4.5
VaC	Vida-Williams very stony loams, 2 to 9 percent slopes	825	0.1
VdC	Vida-Williams-Bowbells loams, 2 to 9 percent slopes	19,080	3.0
WaD	Wabek loam, 9 to 25 percent slopes	330	0.1
WbC	Wabek-Bowdle loams, 3 to 9 percent slopes	770	0.1
WnA	Williams-Bowbells loams, 0 to 3 percent slopes	75,670	11.8
WnB	Williams-Bowbells loams, 1 to 6 percent slopes	91,100	14.2
WoA	Williams-Bowbells-Nishon complex, 0 to 3 percent slopes	56,080	8.8
WoB	Williams-Bowbells-Nishon complex, 1 to 6 percent slopes	39,690	6.2
WpA	Williams-Bowbells-Noonan loams, 0 to 3 percent slopes	23,730	3.7
WpB	Williams-Bowbells-Noonan loams, 1 to 6 percent slopes	16,310	2.6
WtC	Williams-Bowbells-Parnell complex, 1 to 9 percent slopes	440	0.1
WvB	Williams-Bowbells-Vida loams, 1 to 6 percent slopes	52,335	8.2
WwB	Williams-Niobell-Noonan loams, 3 to 6 percent slopes	3,830	0.6
WxC	Williams-Vida-Bowbells complex, 2 to 9 percent slopes	11,920	1.9
WzD	Williams-Zahill-Bowbells loams, 2 to 15 percent slopes	14,240	2.2
ZaE	Zahill loam, 15 to 40 percent slopes	3,850	0.6
ZcE	Zahill very stony loam, 6 to 25 percent slopes	2,040	0.3
ZlD	Zahill-La Prairie complex, 2 to 25 percent slopes	4,660	0.7
ZmC	Zahl-Max loams, 6 to 9 percent slopes	6,150	1.0
ZmD	Zahl-Max loams, 9 to 20 percent slopes	3,035	0.5
	Water	2,000	0.3
	Total	638,720	100.0

* Less than 0.1 percent.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE

[Yields are those that can be expected under a high level of management. Absence of a yield indicates that the soil is not suited to the crop or the crop generally is not grown on the soil]

Soil name and map symbol	Corn	Oats	Spring wheat	Alfalfa hay	Cool-season grasses
	Bu	Bu	Bu	Ton	AUM*
Bb Bowbells	51	67	31	3.0	5.0
BoA Bowdle	30	44	21	1.2	2.0
BrA Bryant-Grassna	45	60	29	2.3	3.8
BrB Bryant-Grassna	42	57	27	2.1	3.5
Ha Harriet	---	---	---	---	---
He Heil	---	---	---	---	---
La La Prairie	45	60	28	3.0	5.0
Lb La Prairie	---	---	---	---	---
LeA Lehr	20	35	17	1.1	1.8
LeB Lehr	14	32	13	1.0	1.7
MaA Manning	22	34	15	1.2	2.0
MbA Manning Variant	---	---	---	---	---
MdA Max-Arnegard	45	59	27	2.1	3.5
MmB Max-Arnegard-Zahl	40	50	24	1.9	3.2
MnB Max-Niobell-Noonan	34	47	23	1.8	3.0
MoA Mondamin	38	57	25	2.0	3.3
MoB Mondamin	37	54	23	1.9	3.2
NaA Niobell-Noonan	25	39	18	1.4	2.3
NbA Niobell-Noonan-Max	27	45	21	1.6	2.7
Nn Nishon	---	---	---	---	---
NoA Noonan-Miranda	10	20	10	0.7	1.2

See footnotes at end of table.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Corn	Oats	Spring wheat	Alfalfa hay	Cool-season grasses
	Bu	Bu	Bu	Ton	AUM*
Pa Parnell	---	---	---	---	---
Pp Parnell	---	---	---	---	---
Pt** Pits	---	---	---	---	---
RaA Raber-Cavo	26	42	21	1.7	2.8
RaB Raber-Cavo	24	40	20	1.7	2.8
Rh Ranslo-Harriet	---	---	---	---	---
TaA Tally	40	46	20	1.6	2.7
TaB Tally	38	44	17	1.5	2.5
Tn Tonka-Nishon	---	---	---	---	---
VaC Vida-Williams	---	---	---	---	---
VdC Vida-Williams-Bowbells	32	46	22	1.6	2.7
WaD Wabek	---	---	---	---	---
WbC Wabek-Bowdle	14	26	12	0.8	1.3
WnA Williams-Bowbells	45	61	30	2.3	3.8
WnB Williams-Bowbells	43	58	28	2.1	3.5
WoA Williams-Bowbells-Nishon	37	56	25	1.8	3.0
WoB Williams-Bowbells-Nishon	35	53	23	1.6	2.7
WpA Williams-Bowbells-Noonan	35	52	26	1.8	3.0
WpB Williams-Bowbells-Noonan	32	50	24	1.7	2.8
WtC Williams-Bowbells-Parnell	26	42	18	1.7	2.8
WvB Williams-Bowbells-Vida	37	53	25	2.0	3.3
WwB Williams-Niobell-Noonan	27	47	23	1.7	2.8
WxC Williams-Vida-Bowbells	---	---	---	---	---

See footnotes at end of table.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Corn	Oats	Spring wheat	Alfalfa hay	Cool-season grasses
	Bu	Bu	Bu	Ton	AUM*
WzD: Williams-Zahill-Bowbells	---	---	---	1.3	2.2
ZaE, ZcE: Zahill	---	---	---	---	---
ZlD: Zahill-La Prairie	---	---	---	---	---
ZmC: Zahl-Max	28	38	16	1.5	2.5
ZmD: Zahl-Max	---	---	---	1.0	1.7

---

* Animal-unit-month: The amount of forage or feed required to feed one animal unit (one cow, one horse, one mule, five sheep, or five goats) for 30 days.

** See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 6.--RANGELAND PRODUCTIVITY

[Only the soils that support rangeland vegetation suitable for grazing are listed]

Soil name and map symbol	Range site name	Potential annual production for kind of growing season		
		Favorable	Average	Unfavorable
		Lb/acre	Lb/acre	Lb/acre
Bb Bowbells	Overflow	4,300	3,600	2,500
BoA Bowdle	Silty	2,900	2,400	1,700
BrA*, BrB*:				
Bryant	Silty	3,400	2,800	2,000
Grassna	Overflow	4,300	3,600	2,500
Ha Harriet	Saline Lowland	3,500	3,200	2,600
He Heil	Closed Depression	3,400	3,100	2,200
La La Prairie	Overflow	3,900	3,300	2,300
Lb La Prairie	Overflow	4,300	3,600	2,500
LeA, LeB Lehr	Shallow to Gravel	2,200	1,800	1,100
MaA Manning	Sandy	2,800	2,400	2,000
MbA Manning Variant	Shallow to Gravel	2,400	2,000	1,200
MdA*:				
Max	Silty	3,100	2,600	1,800
Arnegard	Overflow	4,300	3,600	2,500
MmB*:				
Max	Silty	3,100	2,600	1,800
Arnegard	Overflow	4,300	3,600	2,500
Zahl	Thin Upland	2,900	2,400	1,700
MnB*:				
Max	Silty	3,100	2,600	1,800
Niobell	Clayey	2,900	2,400	1,700
Noonan	Claypan	2,200	1,800	1,300
MoA, MoB Mondamin	Clayey	3,100	2,600	1,800
NaA*:				
Niobell	Clayey	2,900	2,400	1,700
Noonan	Claypan	2,200	1,800	1,300
NbA*:				
Niobell	Clayey	2,900	2,400	1,700
Noonan	Claypan	2,200	1,800	1,300
Max	Silty	3,100	2,600	1,800

See footnote at end of table.

TABLE 6.--RANGELAND PRODUCTIVITY--Continued

Soil name and map symbol	Range site name	Potential annual production for kind of growing season		
		Favorable Lb/acre	Average Lb/acre	Unfavorable Lb/acre
Nn Nishon	Closed Depression	3,700	3,400	2,400
NoA*:				
Noonan	Claypan	2,200	1,800	1,300
Miranda	Thin Claypan	1,600	1,300	800
Pa Parnell	Shallow Marsh	6,600	6,000	4,800
RaA*, RaB*:				
Raber	Clayey	3,100	2,600	1,800
Cavo	Claypan	2,500	2,100	1,500
Rh*:				
Ranslo	Subirrigated	4,800	4,400	3,500
Harriet	Saline Lowland	3,500	3,200	2,600
TaA, TaB Tally	Sandy	3,100	2,600	1,800
Tn*:				
Tonka	Wet Meadow	4,700	4,300	4,000
Nishon	Closed Depression	3,700	3,400	2,400
VaC*:				
Vida	Silty	2,500	2,100	1,500
Williams	Silty	2,700	2,300	1,600
VdC*:				
Vida	Silty	3,000	2,500	1,750
Williams	Silty	3,100	2,600	1,800
Bowbells	Overflow	4,300	3,600	2,500
WaD Wabek	Very Shallow	1,600	1,300	800
WbC*:				
Wabek	Very Shallow	1,600	1,300	800
Bowdle	Silty	2,900	2,400	1,700
WnA*, WnB*:				
Williams	Silty	3,100	2,600	1,800
Bowbells	Overflow	4,300	3,600	2,500
WoA*, WoB*:				
Williams	Silty	3,100	2,600	1,800
Bowbells	Overflow	4,300	3,600	2,500
Nishon	Closed Depression	3,700	3,400	2,400
WpA*, WpB*:				
Williams	Silty	3,100	2,600	1,800
Bowbells	Overflow	4,300	3,600	2,500
Noonan	Claypan	2,200	1,800	1,300

See footnote at end of table.

TABLE 6.--RANGELAND PRODUCTIVITY--Continued

Soil name and map symbol	Range site name	Potential annual production for kind of growing season		
		Favorable	Average	Unfavorable
		Lb/acre	Lb/acre	Lb/acre
WtC*:				
Williams	Silty	3,100	2,600	1,800
Bowbells	Overflow	4,300	3,600	2,500
Parnell	Shallow Marsh	6,600	6,000	4,800
WvB*:				
Williams	Silty	3,100	2,600	1,800
Bowbells	Overflow	4,300	3,600	2,500
Vida	Silty	3,000	2,500	1,750
WwB*:				
Williams	Silty	3,100	2,600	1,800
Niobell	Clayey	2,900	2,400	1,700
Noonan	Claypan	2,200	1,800	1,300
WxC*:				
Williams	Silty	2,900	2,450	1,700
Vida	Silty	2,750	2,300	1,600
Bowbells	Overflow	4,300	3,600	2,500
WzD*:				
Williams	Silty	3,100	2,600	1,800
Zahill	Thin Upland	2,600	2,200	1,600
Bowbells	Overflow	4,300	3,600	2,500
ZaE Zahill	Thin Upland	2,600	2,200	1,600
ZcE Zahill	Thin Upland	2,500	2,000	1,500
ZlD*:				
Zahill	Thin Upland	2,600	2,200	1,600
La Prairie	Overflow	4,300	3,600	2,500
ZmC*, ZmD*:				
Zahl	Thin Upland	2,900	2,400	1,700
Max	Silty	3,100	2,600	1,800

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

[The symbol < means less than; > means more than. Absence of an entry indicates that trees generally do not grow to the given height on that soil]

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
Bb---------------- Bowbells	---	Tatarian honeysuckle, Siberian crabapple, eastern redcedar, common chokecherry, Siberian peashrub, American plum, Peking cotoneaster.	Golden willow, ponderosa pine, Black Hills spruce, green ash.	---	Plains cottonwood.
BoA--------------- Bowdle	---	Ponderosa pine, green ash, Siberian peashrub, Rocky Mountain juniper, Russian-olive, eastern redcedar.	Siberian elm------	---	---
BrA*, BrB*:					
Bryant-----------	---	Russian-olive, eastern redcedar, common chokecherry, Siberian peashrub, American plum, Tatarian honeysuckle, lilac.	Black Hills spruce, ponderosa pine, green ash, bur oak, Siberian crabapple.	---	---
Grassna----------	---	Tatarian honeysuckle, Siberian crabapple, eastern redcedar, common chokecherry, Siberian peashrub, American plum, Peking cotoneaster.	Golden willow, ponderosa pine, Black Hills spruce, green ash.	---	Plains cottonwood.
Ha. Harriet					
He. Heil					
La---------------- La Prairie	---	Siberian crabapple, common chokecherry, eastern redcedar, Siberian peashrub, American plum, Tatarian honeysuckle, Peking cotoneaster.	Golden willow, green ash, ponderosa pine, Black Hills spruce.	---	Plains cottonwood.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
Lb: La Prairie	---	Ponderosa pine, Peking cotoneaster, redosier dogwood, eastern redcedar, common chokecherry, Siberian peashrub, Tatarian honeysuckle, American plum.	Black Hills spruce, green ash.	Golden willow	Eastern cottonwood.
LeA, LeB: Lehr	---	Green ash, ponderosa pine, Russian-olive, Siberian peashrub, eastern redcedar, Rocky Mountain juniper.	Siberian elm	---	---
MaA: Manning	---	Green ash, ponderosa pine, Russian-olive, Siberian peashrub, eastern redcedar, Rocky Mountain juniper.	Siberian elm	---	---
MbA: Manning Variant	---	Green ash, Russian-olive, ponderosa pine, eastern redcedar, Rocky Mountain juniper, Siberian peashrub.	Siberian elm	---	---
MdA*:					
Max	---	Russian-olive, Siberian peashrub, common chokecherry, eastern redcedar, Tatarian honeysuckle, American plum, lilac.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce.	---	---
Arnegard	---	Siberian crabapple, common chokecherry, Tatarian honeysuckle, eastern redcedar, Siberian peashrub, American plum, Peking cotoneaster.	Golden willow, ponderosa pine, Black Hills spruce, green ash.	---	Plains cottonwood.
MmB*:					
Max	---	Russian-olive, Siberian peashrub, common chokecherry, eastern redcedar, Tatarian honeysuckle, American plum, lilac.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce.	---	---

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
MmB*:					
Arnegard	---	Siberian crabapple, common chokecherry, Tatarian honeysuckle, eastern redcedar, Siberian peashrub, American plum, Peking cotoneaster.	Golden willow, ponderosa pine, Black Hills spruce, green ash.	---	Plains cottonwood.
Zahl	Eastern redcedar, Siberian peashrub, Tatarian honeysuckle.	Ponderosa pine, green ash, Russian-olive, Rocky Mountain juniper.	Siberian elm	---	---
MnB*:					
Max	---	Russian-olive, Siberian peashrub, common chokecherry, eastern redcedar, Tatarian honeysuckle, American plum, lilac.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce.	---	---
Niobell	Lilac, Siberian peashrub, golden currant, American plum.	Green ash, ponderosa pine, eastern redcedar, Rocky Mountain juniper, Russian-olive, common chokecherry.	Siberian elm	---	---
Noonan	Green ash, Russian-olive, eastern redcedar, Rocky Mountain juniper, Siberian peashrub, silver buffaloberry.	Siberian elm, ponderosa pine.	---	---	---
MoA, MoB Mondamin	American plum, lilac, golden currant.	Green ash, ponderosa pine, Russian-olive, eastern redcedar, Rocky Mountain juniper, common chokecherry, Siberian peashrub.	Siberian elm	---	---
NaA*:					
Niobell	Lilac, Siberian peashrub, golden currant, American plum.	Green ash, ponderosa pine, eastern redcedar, Rocky Mountain juniper, Russian-olive, common chokecherry.	Siberian elm	---	---

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
NaA*:					
Noonan	Green ash, Russian-olive, eastern redcedar, Rocky Mountain juniper, Siberian peashrub, silver buffaloberry.	Siberian elm, ponderosa pine.	---	---	---
NbA*:					
Niobell	Lilac, Siberian peashrub, golden currant, American plum.	Green ash, ponderosa pine, eastern redcedar, Rocky Mountain juniper, Russian-olive, common chokecherry.	Siberian elm	---	---
Noonan	Green ash, Russian-olive, eastern redcedar, Rocky Mountain juniper, Siberian peashrub, silver buffaloberry.	Siberian elm, ponderosa pine.	---	---	---
Max	---	Russian-olive, Siberian peashrub, common chokecherry, eastern redcedar, Tatarian honeysuckle, American plum, lilac.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce.	---	---
Nn.					
Nishon					
NoA*:					
Noonan	Green ash, Russian-olive, eastern redcedar, Rocky Mountain juniper, Siberian peashrub, silver buffaloberry.	Siberian elm, ponderosa pine.	---	---	---
Miranda.					
Pa, Pp.					
Parnell					
Pt*.					
Pits					
RaA*, RaB*:					
Raber	Lilac	Eastern redcedar, common chokecherry, Siberian peashrub, American plum, silver buffaloberry.	Ponderosa pine, green ash, hackberry, Russian-olive, Siberian crabapple, Black Hills spruce.	---	---

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	<8	8-15	16-25	26-35	>35
RaA*, RaB*:					
Cavo	Eastern redcedar, Rocky Mountain juniper, Siberian peashrub, silver buffaloberry, lilac.	Siberian elm, green ash, ponderosa pine, Russian-olive.	---	---	---
Rh*:					
Ranslo	Siberian peashrub, American plum.	Black Hills spruce, Siberian crabapple, eastern redcedar, common chokecherry, lilac.	Blue spruce, green ash, ponderosa pine.	Golden willow	Plains cottonwood.
Harriet.					
TaA, TaB Tally	Tatarian honeysuckle, silver buffaloberry, lilac.	Eastern redcedar, bur oak, Siberian crabapple, common chokecherry, Siberian peashrub, American plum.	Ponderosa pine, Russian-olive, green ash.	---	---
Tn*:					
Tonka.					
Nishon.					
VaC*:					
Vida.					
Williams.					
VdC*:					
Vida	---	Russian-olive, eastern redcedar, Tatarian honeysuckle, common chokecherry, lilac, Siberian peashrub, American plum.	Green ash, ponderosa pine, Black Hills spruce, bur oak, Siberian crabapple.	---	---
Williams	---	Russian-olive, eastern redcedar, lilac, Siberian peashrub, common chokecherry, Tatarian honeysuckle, American plum.	Siberian crabapple, green ash, ponderosa pine, bur oak, Black Hills spruce.	---	---
Bowbells	---	Tatarian honeysuckle, Siberian crabapple, eastern redcedar, common chokecherry, Siberian peashrub, American plum, Peking cotoneaster.	Golden willow, ponderosa pine, Black Hills spruce, green ash.	---	Plains cottonwood.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	<8	8-15	16-25	26-35	>35
WaD. Wabek					
WbC*: Wabek.					
Bowdle	---	Ponderosa pine, green ash, Siberian peashrub, Rocky Mountain juniper, Russian-olive, eastern redcedar.	Siberian elm	---	---
WnA*, WnB*: Williams	---	Russian-olive, eastern redcedar, lilac, Siberian peashrub, common chokecherry, Tatarian honeysuckle, American plum.	Siberian crabapple, green ash, ponderosa pine, bur oak, Black Hills spruce.	---	---
Bowbells	---	Tatarian honeysuckle, Siberian crabapple, eastern redcedar, common chokecherry, Siberian peashrub, American plum, Peking cotoneaster.	Golden willow, ponderosa pine, Black Hills spruce, green ash.	---	Plains cottonwood.
WoA*, WoB*: Williams	---	Russian-olive, eastern redcedar, lilac, Siberian peashrub, common chokecherry, Tatarian honeysuckle, American plum.	Siberian crabapple, green ash, ponderosa pine, bur oak, Black Hills spruce.	---	---
Bowbells	---	Tatarian honeysuckle, Siberian crabapple, eastern redcedar, common chokecherry, Siberian peashrub, American plum, Peking cotoneaster.	Golden willow, ponderosa pine, Black Hills spruce, green ash.	---	Plains cottonwood.
Nishon.					
WpA*, WpB*: Williams	---	Russian-olive, eastern redcedar, lilac, Siberian peashrub, common chokecherry, Tatarian honeysuckle, American plum.	Siberian crabapple, green ash, ponderosa pine, bur oak, Black Hills spruce.	---	---

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	<8	8-15	16-25	26-35	>35
WpA*, WpB*:					
Bowbells	---	Tatarian honeysuckle, Siberian crabapple, eastern redcedar, common chokecherry, Siberian peashrub, American plum, Peking cotoneaster.	Golden willow, ponderosa pine, Black Hills spruce, green ash.	---	Plains cottonwood.
Noonan	Green ash, Russian-olive, eastern redcedar, Rocky Mountain juniper, Siberian peashrub, silver buffaloberry.	Siberian elm, ponderosa pine.	---	---	---
WtC*:					
Williams	---	Russian-olive, eastern redcedar, lilac, Siberian peashrub, common chokecherry, Tatarian honeysuckle, American plum.	Siberian crabapple, green ash, ponderosa pine, bur oak, Black Hills spruce.	---	---
Bowbells	---	Tatarian honeysuckle, Siberian crabapple, eastern redcedar, common chokecherry, Siberian peashrub, American plum, Peking cotoneaster.	Golden willow, ponderosa pine, Black Hills spruce, green ash.	---	Plains cottonwood.
Parnell.					
WvB*:					
Williams	---	Russian-olive, eastern redcedar, lilac, Siberian peashrub, common chokecherry, Tatarian honeysuckle, American plum.	Siberian crabapple, green ash, ponderosa pine, bur oak, Black Hills spruce.	---	---
Bowbells	---	Tatarian honeysuckle, Siberian crabapple, eastern redcedar, common chokecherry, Siberian peashrub, American plum, Peking cotoneaster.	Golden willow, ponderosa pine, Black Hills spruce, green ash.	---	Plains cottonwood.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	<8	8-15	16-25	26-35	>35
WvB*:					
Vida	---	Russian-olive, eastern redcedar, Tatarian honeysuckle, common chokecherry, lilac, Siberian peashrub, American plum.	Green ash, ponderosa pine, Black Hills spruce, bur oak, Siberian crabapple.	---	---
WwB*:					
Williams	---	Russian-olive, eastern redcedar, lilac, Siberian peashrub, common chokecherry, Tatarian honeysuckle, American plum.	Siberian crabapple, green ash, ponderosa pine, bur oak, Black Hills spruce.	---	---
Niobell	Lilac, Siberian peashrub, golden currant, American plum.	Green ash, ponderosa pine, eastern redcedar, Rocky Mountain juniper, Russian-olive, common chokecherry.	Siberian elm	---	---
Noonan	Green ash, Russian-olive, eastern redcedar, Rocky Mountain juniper, Siberian peashrub, silver buffaloberry.	Siberiam elm, ponderosa pine.	---	---	---
WxC*:					
Williams.					
Vida.					
Bowbells	---	Tatarian honeysuckle, Siberian crabapple, eastern redcedar, common chokecherry, Siberian peashrub, American plum, Peking cotoneaster.	Golden willow, ponderosa pine, Black Hills spruce, green ash.	---	Plains cottonwood.
WzD*:					
Williams	---	Russian-olive, eastern redcedar, lilac, Siberian peashrub, common chokecherry, Tatarian honeysuckle, American plum.	Siberian crabapple, green ash, ponderosa pine, bur oak, Black Hills spruce.	---	---
Zahill	Eastern redcedar, Siberian peashrub, Tatarian honeysuckle.	Ponderosa pine, green ash, Russian-olive, Rocky Mountain juniper.	Siberian elm	---	---

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	<8	8-15	16-25	26-35	>35
WzD*:					
Bowbells	---	Tatarian honeysuckle, Siberian crabapple, eastern redcedar, common chokecherry, Siberian peashrub, American plum, Peking cotoneaster.	Golden willow, ponderosa pine, Black Hills spruce, green ash.	---	Plains cottonwood.
ZaE, ZcE. Zahill					
ZlD*: Zahill.					
La Prairie	---	Ponderosa pine, Peking cotoneaster, redosier dogwood, eastern redcedar, common chokecherry, Siberian peashrub, Tatarian honeysuckle, American plum.	Black Hills spruce, green ash.	Golden willow	Eastern cottonwood.
ZmC*:					
Zahl	Eastern redcedar, Siberian peashrub, Tatarian honeysuckle.	Ponderosa pine, green ash, Russian-olive, Rocky Mountain juniper.	Siberian elm	---	---
Max	---	Russian-olive, Siberian peashrub, common chokecherry, eastern redcedar, Tatarian honeysuckle, American plum, lilac.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce.	---	---
ZmD*: Zahl.					
Max	---	Russian-olive, Siberian peashrub, common chokecherry, eastern redcedar, Tatarian honeysuckle, American plum, lilac.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce.	---	---

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 8.--WILDLIFE HABITAT POTENTIALS

[See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Potential for habitat elements						Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Wetland plants	Shallow water areas	Openland wildlife	Wetland wildlife	Rangeland wildlife
Bb Bowbells	Good	Good	Fair	Good	Very poor	Very poor	Good	Very poor	Fair.
BoA Bowdle	Fair	Fair	Good	Poor	Very poor	Very poor	Fair	Very poor	Good.
BrA*:									
Bryant	Good	Good	Good	Good	Very poor	Very poor	Good	Very poor	Good.
Grassna	Good	Good	Fair	Good	Very poor	Very poor	Good	Very poor	Fair.
BrB*:									
Bryant	Good	Good	Good	Good	Very poor	Very poor	Good	Very poor	Good.
Grassna	Good	Good	Fair	Good	Very poor	Very poor	Good	Very poor	Fair.
Ha Harriet	Very poor	Poor	Fair	Poor	Fair	Fair	Very poor	Fair	Fair.
He Heil	Very poor	Poor	Poor	Poor	Fair	Fair	Very poor	Fair	Poor.
La La Prairie	Good	Good	Fair	Good	Very poor	Very poor	Good	Very poor	Fair.
Lb La Prairie	Very poor	Poor	Fair	Poor	Very poor	Very poor	Very poor	Very poor	Fair.
LeA, LeB Lehr	Poor	Fair	Poor	Poor	Very poor	Very poor	Poor	Very poor	Poor.
MaA Manning	Fair	Good	Good	Fair	Very poor	Very poor	Fair	Very poor	Fair.
MbA Manning Variant	Poor	Fair	Poor	Poor	Very poor	Very poor	Poor	Very poor	Poor.
MdA*:									
Max	Good	Good	Good	Good	Very poor	Very poor	Good	Very poor	Good.
Arnegard	Good	Good	Fair	Good	Very poor	Very poor	Good	Very poor	Fair.
MmB*:									
Max	Good	Good	Good	Good	Very poor	Very poor	Good	Very poor	Good.
Arnegard	Good	Good	Fair	Good	Very poor	Very poor	Good	Very poor	Fair.
Zahl	Fair	Fair	Fair	Poor	Very poor	Very poor	Fair	Very poor	Fair.
MnB*:									
Max	Good	Good	Good	Good	Very poor	Very poor	Good	Very poor	Good.
Niobell	Fair	Fair	Good	Fair	Very poor	Very poor	Fair	Very poor	Good.
Noonan	Poor	Poor	Poor	Poor	Very poor	Very poor	Poor	Very poor	Poor.
MoA Mondamin	Good	Fair	Good	Fair	Very poor	Very poor	Good	Very poor	Good.
MoB Mondamin	Fair	Fair	Good	Fair	Very poor	Very poor	Fair	Very poor	Good.

See footnote at end of table.

TABLE 8.--WILDLIFE HABITAT POTENTIALS--Continued

Soil name and map symbol	Potential for habitat elements						Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Wetland plants	Shallow water areas	Openland wildlife	Wetland wildlife	Rangeland wildlife
NaA*:									
Niobell	Fair	Fair	Good	Fair	Very poor	Very poor	Fair	Very poor	Good.
Noonan	Poor	Poor	Poor	Poor	Very poor	Very poor	Poor	Very poor	Poor.
NbA*:									
Niobell	Fair	Fair	Good	Fair	Very poor	Very poor	Fair	Very poor	Good.
Noonan	Poor	Poor	Poor	Poor	Very poor	Very poor	Poor	Very poor	Poor.
Max	Good	Good	Good	Good	Very poor	Very poor	Good	Very poor	Good.
Nn Nishon	Poor	Poor	Poor	Poor	Fair	Fair	Poor	Fair	Poor.
NoA*:									
Noonan	Poor	Poor	Poor	Poor	Very poor	Very poor	Poor	Very poor	Poor.
Miranda	Very poor	Very poor	Poor	Poor	Very poor	Very poor	Very poor	Very poor	Poor.
Pa, Pp Parnell	Very poor	Very poor	Very poor	Very poor	Good	Good	Very poor	Good	Very poor.
Pt*. Pits									
RaA*, RaB*:									
Raber	Good	Good	Good	Good	Very poor	Very poor	Good	Very poor	Good.
Cavo	Poor	Poor	Poor	Poor	Very poor	Very poor	Poor	Very poor	Poor.
Rh*:									
Ranslo	Poor	Poor	Good	Poor	Poor	Poor	Poor	Poor	Good.
Harriet	Very poor	Poor	Fair	Poor	Fair	Fair	Very poor	Fair	Fair.
TaA, TaB Tally	Fair	Fair	Good	Fair	Very poor	Very poor	Fair	Very poor	Fair.
Tn*:									
Tonka	Poor	Poor	Fair	Poor	Fair	Fair	Poor	Poor	Poor.
Nishon	Poor	Poor	Poor	Poor	Fair	Fair	Poor	Fair	Poor.
VaC*:									
Vida	Very poor	Very poor	Good	Poor	Very poor	Very poor	Very poor	Very poor	Good.
Williams	Very poor	Very poor	Good	Poor	Very poor	Very poor	Very poor	Very poor	Good.
VdC*:									
Vida	Poor	Fair	Good	Good	Very poor	Very poor	Fair	Very poor	Good.
Williams	Fair	Good	Good	Good	Very poor	Very poor	Good	Very poor	Good.
Bowbells	Good	Good	Fair	Good	Very poor	Very poor	Good	Very poor	Fair.
WaD Wabek	Very poor	Poor	Poor	Very poor	Very poor	Very poor	Very poor	Very poor	Poor.
WbC*:									
Wabek	Very poor	Poor	Poor	Very poor	Very poor	Very poor	Very poor	Very poor	Poor.
Bowdle	Fair	Fair	Good	Poor	Very poor	Very poor	Fair	Very poor	Good.
WnA*, WnB*:									
Williams	Good	Good	Good	Good	Very poor	Very poor	Good	Very poor	Good.

See footnote at end of table.

TABLE 8.--WILDLIFE HABITAT POTENTIALS--Continued

Soil name and map symbol	Potential for habitat elements						Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Wetland plants	Shallow water areas	Openland wildlife	Wetland wildlife	Rangeland wildlife
WnA*, WnB*:									
Bowbells	Good	Good	Fair	Good	Very poor	Very poor	Good	Very poor	Fair.
WoA*, WoB*:									
Williams	Good	Good	Good	Good	Very poor	Very poor	Good	Very poor	Good.
Bowbells	Good	Good	Fair	Good	Very poor	Very poor	Good	Very poor	Fair.
Nishon	Fair	Fair	Fair	Poor	Good	Good	Fair	Good	Fair.
WpA*, WpB*:									
Williams	Good	Good	Good	Good	Very poor	Very poor	Good	Very poor	Good.
Bowbells	Good	Good	Fair	Good	Very poor	Very poor	Good	Very poor	Fair.
Noonan	Poor	Poor	Poor	Poor	Very poor	Very poor	Poor	Very poor	Poor.
WtC*:									
Williams	Fair	Good	Good	Good	Very poor	Very poor	Good	Very poor	Good.
Bowbells	Good	Good	Fair	Good	Very poor	Very poor	Good	Very poor	Fair.
Parnell	Very poor	Very poor	Very poor	Very poor	Good	Good	Very poor	Good	Very poor.
WvB*:									
Williams	Good	Good	Good	Good	Very poor	Very poor	Good	Very poor	Good.
Bowbells	Good	Good	Fair	Good	Very poor	Very poor	Good	Very poor	Fair.
Vida	Fair	Good	Good	Good	Very poor	Very poor	Good	Very poor	Good.
WwB*:									
Williams	Good	Good	Good	Good	Very poor	Very poor	Good	Very poor	Good.
Niobell	Fair	Fair	Good	Fair	Very poor	Very poor	Fair	Very poor	Fair.
Noonan	Poor	Poor	Poor	Poor	Very poor	Very poor	Poor	Very poor	Very poor.
WxC*:									
Williams	Poor	Good	Good	Good	Very poor	Very poor	Fair	Very poor	Good.
Vida	Poor	Good	Good	Good	Very poor	Very poor	Fair	Very poor	Good.
Bowbells	Good	Good	Fair	Good	Very poor	Very poor	Good	Very poor	Fair.
WzD*:									
Williams	Poor	Good	Good	Good	Very poor	Very poor	Fair	Very poor	Good.
Zahill	Very poor	Fair	Fair	Fair	Very poor	Very poor	Poor	Very poor	Good.
Bowbells	Good	Good	Fair	Good	Very poor	Very poor	Good	Very poor	Fair.
ZaE Zahill	Very poor	Very poor	Fair	Poor	Very poor	Very poor	Very poor	Very poor	Fair.
ZcE Zahill	Very poor	Very poor	Fair	Poor	Very poor	Very poor	Very poor	Very poor	Fair.
ZlD*:									
Zahill	Very poor	Poor	Fair	Poor	Very poor	Very poor	Fair	Very poor	Fair.
La Prairie	Very poor	Poor	Fair	Poor	Very poor	Very poor	Very poor	Very poor	Fair.
ZmC*:									
Zahl	Poor	Fair	Fair	Poor	Very poor	Very poor	Poor	Very poor	Fair.
Max	Fair	Good	Good	Poor	Very poor	Very poor	Fair	Very poor	Good.

See footnote at end of table.

TABLE 8.--WILDLIFE HABITAT POTENTIALS--Continued

Soil name and map symbol	Potential for habitat elements						Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Wetland plants	Shallow water areas	Openland wildlife	Wetland wildlife	Rangeland wildlife
ZmD*:									
Zahl---------------	Very poor	Poor	Fair	Poor	Very poor	Very poor	Very poor	Very poor	Fair.
Max----------------	Very poor	Poor	Good	Poor	Very poor	Very poor	Very poor	Very poor	Good.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--BUILDING SITE DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
Bb----------------- Bowbells	Moderate: wetness, flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, flooding, frost action.
BoA----------------- Bowdle	Severe: cutbanks cave.	Slight-----------	Slight-----------	Slight------------	Slight.
BrA*:					
Bryant-----------	Slight-----------	Slight-----------	Slight-----------	Slight------------	Moderate: low strength, frost action.
Grassna----------	Moderate: wetness, flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, flooding.
BrB*:					
Bryant-----------	Slight-----------	Slight-----------	Slight-----------	Moderate: slope.	Moderate: low strength, frost action.
Grassna----------	Moderate: wetness, flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, flooding.
Ha----------------- Harriet	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: wetness, flooding, low strength.
He----------------- Heil	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: low strength, ponding, shrink-swell.
La----------------- La Prairie	Moderate: wetness.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength.
Lb----------------- La Prairie	Moderate: wetness, flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding, low strength.
LeA----------------- Lehr	Severe: cutbanks cave.	Slight-----------	Slight-----------	Slight------------	Slight.
LeB----------------- Lehr	Severe: cutbanks cave.	Slight-----------	Slight-----------	Moderate: slope.	Slight.
MaA----------------- Manning	Severe: cutbanks cave.	Slight-----------	Slight-----------	Slight------------	Slight.
MbA----------------- Manning Variant	Severe: cutbanks cave, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Severe: frost action.
MdA*:					
Max---------------	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: low strength, frost action.

See footnote at end of table.

TABLE 9.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
MdA*:					
Arnegard	Moderate: wetness, flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, flooding.
MmB*:					
Max	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: low strength, frost action.
Arnegard	Moderate: wetness, flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, flooding.
Zahl	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.
MnB*:					
Max	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: low strength, frost action.
Niobell	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: low strength, frost action.
Noonan	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.
MoA, MoB Mondamin	Slight	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
NaA*:					
Niobell	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: low strength, frost action.
Noonan	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.
NbA*:					
Niobell	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: low strength, frost action.
Noonan	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.
Max	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: low strength, frost action.
Nn Nishon	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: low strength, ponding.
NoA*:					
Noonan	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.
Miranda	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.

See footnote at end of table.

TABLE 9.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
Pa, Pp----------- Parnell	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, low strength, frost action.
Pt*. Pits					
RaA*:					
Raber------------	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Cavo-------------	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength.
RaB*:					
Raber------------	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Cavo-------------	Moderate: too clayey.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.
Rh*:					
Ranslo-----------	Severe: wetness.	Severe: flooding, shrink-swell, wetness.	Severe: flooding, shrink-swell, wetness.	Severe: flooding, shrink-swell, wetness.	Severe: flooding, frost action, low strength.
Harriet----------	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: wetness, flooding, low strength.
TaA--------------- Tally	Severe: cutbanks cave.	Slight-----------	Slight-----------	Slight------------	Moderate: frost action.
TaB--------------- Tally	Severe: cutbanks cave.	Slight-----------	Slight-----------	Moderate: slope.	Moderate: frost action.
Tn*:					
Tonka------------	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: low strength, ponding, frost action.
Nishon-----------	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: low strength, ponding.
VaC*:					
Vida-------------	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: low strength, frost action.
Williams---------	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.
VdC*:					
Vida-------------	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: low strength, frost action.

See footnote at end of table.

TABLE 9.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
VdC*:					
Williams	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.
Bowbells	Moderate: wetness, flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, flooding, frost action.
WaD Wabek	Severe: slope, cutbanks cave.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
WbC*:					
Wabek	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight.
Bowdle	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight.
WnA*:					
Williams	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.
Bowbells	Moderate: wetness, flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, flooding, frost action.
WnB*:					
Williams	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.
Bowbells	Moderate: wetness, flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, flooding, frost action.
WoA*:					
Williams	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.
Bowbells	Moderate: wetness, flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, flooding, frost action.
Nishon	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: low strength, ponding.
WoB*:					
Williams	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.
Bowbells	Moderate: wetness, flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, flooding, frost action.
Nishon	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: low strength, ponding.

See footnote at end of table.

TABLE 9.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
WpA*:					
Williams---------	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.
Bowbells---------	Moderate: wetness, flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, flooding, frost action.
Noonan-----------	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.
WpB*:					
Williams---------	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.
Bowbells---------	Moderate: wetness, flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, flooding, frost action.
Noonan-----------	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.
WtC*:					
Williams---------	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.
Bowbells---------	Moderate: wetness, flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, flooding, frost action.
Parnell----------	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, low strength, frost action.
WvB*:					
Williams---------	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.
Bowbells---------	Moderate: wetness, flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, flooding, frost action.
Vida-------------	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: low strength, frost action.
WwB*:					
Williams---------	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.
Niobell----------	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: low strength, frost action.
Noonan-----------	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.

See footnote at end of table.

TABLE 9.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
WxC*:					
Williams	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.
Vida	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: low strength, frost action.
Bowbells	Moderate: wetness, flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, flooding, frost action.
WzD*:					
Williams	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.
Zahill	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Bowbells	Moderate: wetness, flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, flooding, frost action.
ZaE Zahill	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
ZcE Zahill	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.
ZlD*:					
Zahill	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
La Prairie	Moderate: wetness, flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding, low strength.
ZmC*:					
Zahl	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.
Max	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: low strength, frost action.
ZmD*:					
Zahl	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.
Max	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Moderate: low strength, slope, frost action.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--SANITARY FACILITIES

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," "good," "fair," and other terms. Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Bb----------------- Bowbells	Severe: flooding, percs slowly.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Fair: too clayey.
BoA---------------- Bowdle	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy, seepage, small stones.
BrA*:					
Bryant-------------	Slight-----------	Moderate: seepage.	Slight-----------	Slight-----------	Good.
Grassna------------	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Fair: too clayey.
BrB*:					
Bryant-------------	Slight-----------	Moderate: slope, seepage.	Slight-----------	Slight-----------	Good.
Grassna------------	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Fair: too clayey.
Ha----------------- Harriet	Severe: flooding, wetness, percs slowly.	Severe: flooding, wetness.	Severe: flooding, wetness, excess sodium.	Severe: flooding, wetness.	Poor: hard to pack, wetness, excess sodium.
He----------------- Heil	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey, excess sodium.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
La----------------- La Prairie	Severe: wetness.	Severe: flooding.	Severe: wetness.	Moderate: flooding.	Good.
Lb----------------- La Prairie	Severe: flooding, wetness.	Severe: flooding.	Severe: flooding, wetness.	Severe: flooding.	Good.
LeA, LeB----------- Lehr	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
MaA---------------- Manning	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
MbA---------------- Manning Variant	Severe: wetness, percs slowly, poor filter.	Severe: seepage, wetness.	Severe: wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy.
MdA*:					
Max----------------	Severe: percs slowly.	Slight-----------	Moderate: too clayey.	Slight-----------	Fair: too clayey.
Arnegard-----------	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding.	Severe: flooding.	Fair: too clayey, wetness.

See footnote at end of table.

TABLE 10.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
MmB*:					
Max	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Arnegard	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding.	Severe: flooding.	Fair: too clayey, wetness.
Zahl	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
MnB*:					
Max	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Niobell	Severe: percs slowly.	Slight	Severe: excess sodium.	Slight	Poor: excess sodium.
Noonan	Severe: percs slowly.	Moderate: slope.	Severe: excess sodium.	Slight	Poor: excess sodium.
MoA Mondamin	Severe: percs slowly.	Slight	Moderate: too clayey.	Slight	Fair: too clayey.
MoB Mondamin	Severe: percs slowly.	Moderate: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
NaA*:					
Niobell	Severe: percs slowly.	Slight	Severe: excess sodium.	Slight	Poor: excess sodium.
Noonan	Severe: percs slowly.	Slight	Severe: excess sodium.	Slight	Poor: excess sodium.
NbA*:					
Niobell	Severe: percs slowly.	Slight	Severe: excess sodium.	Slight	Poor: excess sodium.
Noonan	Severe: percs slowly.	Slight	Severe: excess sodium.	Slight	Poor: excess sodium.
Max	Severe: percs. slowly.	Slight	Moderate: too clayey.	Slight	Fair: too clayey.
Nn Nishon	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
NoA*:					
Noonan	Severe: percs slowly.	Moderate: slope.	Severe: excess sodium.	Slight	Poor: excess sodium.
Miranda	Severe: percs slowly.	Moderate: slope.	Severe: excess sodium.	Slight	Poor: excess sodium.
Pa, Pp Parnell	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
Pt*. Pits					

See footnote at end of table.

TABLE 10.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
RaA*:					
Raber	Severe: percs slowly.	Slight	Severe: too clayey.	Slight	Poor: too clayey, hard to pack.
Cavo	Severe: percs slowly.	Slight	Severe: too clayey, excess sodium.	Slight	Poor: too clayey, hard to pack, excess sodium.
RaB*:					
Raber	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight	Poor: too clayey, hard to pack.
Cavo	Severe: percs slowly.	Moderate: slope.	Severe: too clayey, excess sodium.	Slight	Poor: too clayey, hard to pack, excess sodium.
Rh*:					
Ranslo	Severe: percs slowly, flooding, wetness.	Slight	Severe: flooding, wetness, excess sodium.	Severe: flooding, wetness.	Poor: wetness, hard to pack, excess sodium.
Harriet	Severe: flooding, wetness, percs slowly.	Severe: flooding, wetness.	Severe: flooding, wetness, excess sodium.	Severe: flooding, wetness.	Poor: hard to pack, wetness, excess sodium.
TaA, TaB Tally	Slight	Severe: seepage.	Severe: seepage.	Severe: seepage.	Fair: too sandy.
Tn*:					
Tonka	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
Nishon	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
VaC*:					
Vida	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Williams	Severe: percs slowly.	Moderate: seepage, slope, large stones.	Moderate: too clayey.	Slight	Fair: too clayey.
VdC*:					
Vida	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Williams	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Bowbells	Severe: flooding, percs slowly.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Fair: too clayey.

See footnote at end of table.

TABLE 10.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
WaD----------------- Wabek	Severe: slope, poor filter.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: too sandy, seepage, small stones.
WbC*:					
Wabek---------------	Severe: poor filter.	Severe: seepage.	Severe: too sandy, seepage.	Severe: seepage.	Poor: too sandy, seepage, small stones.
Bowdle--------------	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy, seepage, small stones.
WnA*:					
Williams------------	Severe: percs slowly.	Moderate: seepage.	Moderate: too clayey.	Slight-----------	Fair: too clayey.
Bowbells------------	Severe: flooding, percs slowly.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Fair: too clayey.
WnB*:					
Williams------------	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight-----------	Fair: too clayey.
Bowbells------------	Severe: flooding, percs slowly.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Fair: too clayey.
WoA*:					
Williams------------	Severe: percs slowly.	Moderate: seepage.	Moderate: too clayey.	Slight-----------	Fair: too clayey.
Bowbells------------	Severe: flooding, percs slowly.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Fair: too clayey.
Nishon--------------	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
WoB*:					
Williams------------	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight-----------	Fair: too clayey.
Bowbells------------	Severe: flooding, percs slowly.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Fair: too clayey.
Nishon--------------	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
WpA*:					
Williams------------	Severe: percs slowly.	Moderate: seepage.	Moderate: too clayey.	Slight-----------	Fair: too clayey.
Bowbells------------	Severe: flooding, percs slowly.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Fair: too clayey.

See footnote at end of table.

TABLE 10.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
WpA*:					
Noonan	Severe: percs slowly.	Slight	Severe: excess sodium.	Slight	Poor: excess sodium.
WpB*:					
Williams	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Bowbells	Severe: flooding, percs slowly.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Fair: too clayey.
Noonan	Severe: percs slowly.	Moderate: slope.	Severe: excess sodium.	Slight	Poor: excess sodium.
WtC*:					
Williams	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Bowbells	Severe: flooding, percs slowly.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Fair: too clayey.
Parnell	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
WvB*:					
Williams	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Bowbells	Severe: flooding, percs slowly.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Fair: too clayey.
Vida	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
WwB*:					
Williams	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Niobell	Severe: percs slowly.	Moderate: slope.	Severe: excess sodium.	Slight	Poor: excess sodium.
Noonan	Severe: percs slowly.	Moderate: slope.	Severe: excess sodium.	Slight	Poor: excess sodium.
WxC*:					
Williams	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Vida	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Bowbells	Severe: flooding, percs slowly.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Fair: too clayey.
WzD*:					
Williams	Severe: percs slowly.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.

See footnote at end of table.

TABLE 10.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
WzD*:					
Zahill	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Bowbells	Severe: flooding, percs slowly.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Fair: too clayey.
ZaE, ZcE Zahill	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
ZlD*:					
Zahill	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
La Prairie	Severe: flooding, wetness.	Severe: flooding.	Severe: flooding, wetness.	Severe: flooding.	Good.
ZmC*:					
Zahl	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Max	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
ZmD*:					
Zahl	Severe: percs slowly.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
Max	Severe: percs slowly.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--CONSTRUCTION MATERIALS

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," "poor," "probable," and "improbable." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Bb-------------------- Bowbells	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
BoA------------------- Bowdle	Good------------------	Probable-------------	Probable-------------	Fair: area reclaim.
BrA*, BrB*:				
Bryant---------------	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Grassna--------------	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Ha-------------------- Harriet	Poor: wetness, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness, excess sodium.
He-------------------- Heil	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness, excess sodium.
La, Lb---------------- La Prairie	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
LeA, LeB-------------- Lehr	Good------------------	Probable-------------	Probable-------------	Poor: small stones, area reclaim.
MaA------------------- Manning	Good------------------	Probable-------------	Probable-------------	Poor: small stones, area reclaim.
MbA------------------- Manning Variant	Fair: thin layer, wetness.	Improbable: thin layer.	Improbable: too sandy.	Poor: small stones.
MdA*:				
Max------------------	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Arnegard-------------	Good------------------	Improbable: excess fines.	Improbable: excess fines.	Good.
MmB*:				
Max------------------	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Arnegard-------------	Good------------------	Improbable: excess fines.	Improbable: excess fines.	Good.
Zahl-----------------	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
MnB*:				
Max------------------	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.

See footnote at end of table.

TABLE 11.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
MnB*:				
Niobell	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess sodium.
Noonan	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess sodium.
MoA, MoB Mondamin	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
NaA*:				
Niobell	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess sodium.
Noonan	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess sodium.
NbA*:				
Niobell	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess sodium.
Noonan	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess sodium.
Max	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Nn Nishon	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
NoA*:				
Noonan	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess sodium.
Miranda	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess sodium.
Pa, Pp Parnell	Poor: wetness, low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
Pt*. Pits				
RaA*, RaB*:				
Raber	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
Cavo	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess sodium.
Rh*:				
Ranslo	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess sodium.
Harriet	Poor: wetness, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness, excess sodium.

See footnote at end of table.

TABLE 11.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
TaA, TaB Tally	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Tn*:				
Tonka	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, wetness.
Nishon	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
VaC*:				
Vida	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
Williams	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: large stones.
VdC*:				
Vida	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones.
Williams	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: large stones.
Bowbells	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
WaD Wabek	Fair: slope.	Probable	Probable	Poor: small stones, slope, area reclaim.
WbC*:				
Wabek	Good	Probable	Probable	Poor: small stones, area reclaim.
Bowdle	Good	Probable	Probable	Fair: area reclaim.
WnA*, WnB*:				
Williams	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: large stones.
Bowbells	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
WoA*, WoB*:				
Williams	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: large stones.
Bowbells	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Nishon	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
WpA*, WpB*:				
Williams	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: large stones.

See footnote at end of table.

TABLE 11.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
WpA*, WpB*:				
Bowbells	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Noonan	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess sodium.
WtC*:				
Williams	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: large stones.
Bowbells	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Parnell	Poor: wetness, low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
WvB*:				
Williams	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: large stones.
Bowbells	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Vida	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones.
WwB*:				
Williams	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: large stones.
Niobell	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess sodium.
Noonan	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess sodium.
WxC*:				
Williams	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: large stones.
Vida	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
Bowbells	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
WzD*:				
Williams	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: large stones, slope.
Zahill	Fair: low strength, slope, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Bowbells	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
ZaE Zahill	Poor: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.

See footnote at end of table.

TABLE 11.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
ZcE-------------------- Zahill	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
ZlD*:				
Zahill----------------	Fair: low strength, slope, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
La Prairie-----------	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
ZmC*:				
Zahl------------------	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Max-------------------	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
ZmD*:				
Zahl------------------	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
Max-------------------	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--WATER MANAGEMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not evaluated]

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Bb Bowbells	Moderate: seepage.	Moderate: piping.	Deep to water	Flooding	Erodes easily	Erodes easily.
BoA Bowdle	Severe: seepage.	Severe: seepage.	Deep to water	Favorable	Too sandy	Favorable.
BrA*:						
Bryant	Moderate: seepage.	Severe: piping.	Deep to water	Favorable	Erodes easily	Erodes easily.
Grassna	Moderate: seepage.	Severe: piping.	Deep to water	Flooding	Favorable	Favorable.
BrB*:						
Bryant	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
Grassna	Moderate: seepage.	Severe: piping.	Deep to water	Flooding	Favorable	Favorable.
Ha Harriet	Slight	Severe: piping, wetness, excess sodium.	Percs slowly, flooding, frost action.	Wetness, percs slowly.	Erodes easily, wetness.	Wetness, excess sodium, erodes easily.
He Heil	Slight	Severe: hard to pack, ponding, excess sodium.	Ponding, percs slowly, excess salt.	Ponding, percs slowly.	Ponding, percs slowly.	Wetness, excess sodium, percs slowly.
La La Prairie	Moderate: seepage.	Moderate: piping, wetness.	Deep to water	Favorable	Favorable	Favorable.
Lb La Prairie	Moderate: seepage.	Moderate: piping, wetness.	Deep to water	Flooding	Favorable	Favorable.
LeA Lehr	Severe: seepage.	Severe: seepage.	Deep to water	Droughty	Too sandy	Droughty.
LeB Lehr	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, slope.	Too sandy	Droughty.
MaA Manning	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, soil blowing.	Too sandy, soil blowing.	Droughty.
MbA Manning Variant	Severe: seepage.	Severe: seepage.	Percs slowly, frost action, cutbanks cave.	Wetness, droughty.	Erodes easily, wetness, too sandy.	Erodes easily, droughty, percs slowly.
MdA*:						
Max	Slight	Severe: piping.	Deep to water	Favorable	Erodes easily	Erodes easily.
Arnegard	Moderate: seepage.	Severe: piping.	Deep to water	Flooding	Favorable	Favorable.
MmB*:						
Max	Moderate: slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
Arnegard	Moderate: seepage.	Severe: piping.	Deep to water	Flooding	Favorable	Favorable.

See footnote at end of table.

TABLE 12.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
MmB*:						
Zahl	Moderate: slope.	Moderate: piping.	Deep to water	Percs slowly, slope.	Erodes easily, percs slowly.	Erodes easily, percs slowly.
MnB*:						
Max	Moderate: slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
Niobell	Slight	Severe: piping, excess sodium.	Deep to water	Percs slowly, excess sodium.	Favorable	Excess sodium, percs slowly.
Noonan	Moderate: slope.	Severe: piping, excess sodium.	Deep to water	Percs slowly, slope, excess sodium.	Percs slowly	Excess sodium, percs slowly.
MoA Mondamin	Slight	Severe: hard to pack.	Deep to water	Percs slowly, erodes easily.	Erodes easily, percs slowly.	Erodes easily, percs slowly.
MoB Mondamin	Moderate: slope.	Severe: hard to pack.	Deep to water	Percs slowly, slope, erodes easily.	Erodes easily, percs slowly.	Erodes easily, percs slowly.
NaA*:						
Niobell	Slight	Severe: piping, excess sodium.	Deep to water	Percs slowly, excess sodium.	Favorable	Excess sodium, percs slowly.
Noonan	Slight	Severe: piping, excess sodium.	Deep to water	Percs slowly, excess sodium.	Percs slowly	Excess sodium, percs slowly.
NbA*:						
Niobell	Slight	Severe: piping, excess sodium.	Deep to water	Percs slowly, excess sodium.	Favorable	Excess sodium, percs slowly.
Noonan	Slight	Severe: piping, excess sodium.	Deep to water	Percs slowly, excess sodium.	Percs slowly	Excess sodium, percs slowly.
Max	Slight	Severe: piping.	Deep to water	Favorable	Erodes easily	Erodes easily.
Nn Nishon	Slight	Severe: ponding.	Percs slowly, ponding.	Ponding, percs slowly, erodes easily.	Erodes easily, ponding, percs slowly.	Wetness, erodes easily, percs slowly.
NoA*:						
Noonan	Moderate: slope.	Severe: piping, excess sodium.	Deep to water	Percs slowly, slope, excess sodium.	Percs slowly	Excess sodium, percs slowly.
Miranda	Slight	Severe: excess sodium.	Deep to water	Percs slowly, excess sodium, excess salt.	Percs slowly	Excess sodium, percs slowly.
Pa, Pp Parnell	Slight	Severe: hard to pack, ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Ponding, percs slowly.	Wetness, percs slowly.
Pt*. Pits						
RaA*:						
Raber	Slight	Moderate: piping, hard to pack.	Deep to water	Percs slowly	Erodes easily, percs slowly.	Erodes easily, percs slowly.

See footnote at end of table.

TABLE 12.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
RaA*: Cavo	Slight	Severe: excess sodium.	Deep to water	Droughty, percs slowly.	Percs slowly	Excess sodium, droughty, percs slowly.
RaB*: Raber	Moderate: slope.	Moderate: piping, hard to pack.	Deep to water	Percs slowly, slope.	Erodes easily, percs slowly.	Erodes easily, percs slowly.
Cavo	Moderate: slope.	Severe: excess sodium.	Deep to water	Droughty, percs slowly, slope.	Percs slowly	Excess sodium, droughty, percs slowly.
Rh*: Ranslo	Slight	Severe: wetness, excess sodium.	Percs slowly, flooding, frost action.	Percs slowly, wetness, excess sodium.	Wetness, percs slowly.	Excess sodium, wetness.
Harriet	Slight	Severe: piping, wetness, excess sodium.	Percs slowly, flooding, frost action.	Wetness, percs slowly.	Erodes easily, wetness.	Wetness, excess sodium, erodes easily.
TaA Tally	Severe: seepage.	Severe: seepage, piping.	Deep to water	Soil blowing	Soil blowing	Favorable.
TaB Tally	Severe: seepage.	Severe: seepage, piping.	Deep to water	Soil blowing, slope.	Soil blowing	Favorable.
Tn*: Tonka	Slight	Severe: ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Erodes easily, ponding, percs slowly.	Wetness, erodes easily, percs slowly.
Nishon	Slight	Severe: ponding.	Percs slowly, ponding.	Ponding, percs slowly, erodes easily.	Erodes easily, ponding, percs slowly.	Wetness, erodes easily, percs slowly.
VaC*: Vida	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Slope	Favorable	Favorable.
Williams	Moderate: seepage, slope.	Moderate: piping, large stones.	Deep to water	Percs slowly, slope.	Large stones, percs slowly.	Large stones, percs slowly.
VdC*: Vida	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Slope, erodes easily.	Erodes easily	Erodes easily.
Williams	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Percs slowly, slope.	Erodes easily	Erodes easily, percs slowly.
Bowbells	Moderate: seepage.	Moderate: piping.	Deep to water	Flooding	Erodes easily	Erodes easily.
WaD Wabek	Severe: seepage, slope.	Severe: seepage, piping.	Deep to water	Droughty, slope.	Slope, too sandy.	Slope, droughty.
WbC*: Wabek	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, slope.	Too sandy	Droughty.

See footnote at end of table.

TABLE 12.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
WbC*:						
Bowdle	Severe: seepage.	Severe: seepage.	Deep to water	Slope	Too sandy	Favorable.
WnA*:						
Williams	Moderate: seepage.	Moderate: piping.	Deep to water	Percs slowly	Erodes easily	Erodes easily, percs slowly.
Bowbells	Moderate: seepage.	Moderate: piping.	Deep to water	Flooding	Erodes easily	Erodes easily.
WnB*:						
Williams	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Percs slowly, slope.	Erodes easily	Erodes easily, percs slowly.
Bowbells	Moderate: seepage.	Moderate: piping.	Deep to water	Flooding	Erodes easily	Erodes easily.
WoA*:						
Williams	Moderate: seepage.	Moderate: piping.	Deep to water	Percs slowly	Erodes easily	Erodes easily, percs slowly.
Bowbells	Moderate: seepage.	Moderate: piping.	Deep to water	Flooding	Erodes easily	Erodes easily.
Nishon	Slight	Severe: ponding.	Percs slowly, ponding.	Ponding, percs slowly, erodes easily.	Erodes easily, ponding, percs slowly.	Wetness, erodes easily, percs slowly.
WoB*:						
Williams	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Percs slowly, slope.	Erodes easily	Erodes easily, percs slowly.
Bowbells	Moderate: seepage.	Moderate: piping.	Deep to water	Flooding	Erodes easily	Erodes easily.
Nishon	Slight	Severe: ponding.	Percs slowly, ponding.	Ponding, percs slowly, erodes easily.	Erodes easily, ponding, percs slowly.	Wetness, erodes easily, percs slowly.
WpA*:						
Williams	Moderate: seepage.	Moderate: piping.	Deep to water	Percs slowly	Erodes easily	Erodes easily, percs slowly.
Bowbells	Moderate: seepage.	Moderate: piping.	Deep to water	Flooding	Erodes easily	Erodes easily.
Noonan	Slight	Severe: piping, excess sodium.	Deep to water	Percs slowly, excess sodium.	Percs slowly	Excess sodium, percs slowly.
WpB*:						
Williams	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Percs slowly, slope.	Erodes easily	Erodes easily, percs slowly.
Bowbells	Moderate: seepage.	Moderate: piping.	Deep to water	Flooding	Erodes easily	Erodes easily.
Noonan	Moderate: slope.	Severe: piping, excess sodium.	Deep to water	Percs slowly, slope, excess sodium.	Percs slowly	Excess sodium, percs slowly.
WtC*:						
Williams	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Percs slowly, slope.	Erodes easily	Erodes easily, percs slowly.

See footnote at end of table.

TABLE 12.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
WtC*:						
Bowbells	Moderate: seepage.	Moderate: piping.	Deep to water	Flooding	Erodes easily	Erodes easily.
Parnell	Slight	Severe: hard to pack, ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Ponding, percs slowly.	Wetness, percs slowly.
WvB*:						
Williams	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Percs slowly, slope.	Erodes easily	Erodes easily, percs slowly.
Bowbells	Moderate: seepage.	Moderate: piping.	Deep to water	Flooding	Erodes easily	Erodes easily.
Vida	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Slope, erodes easily.	Erodes easily	Erodes easily.
WwB*:						
Williams	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Percs slowly, slope.	Erodes easily	Erodes easily, percs slowly.
Niobell	Moderate: slope.	Severe: piping, excess sodium.	Deep to water	Percs slowly, slope, excess sodium.	Favorable	Excess sodium, percs slowly.
Noonan	Moderate: slope.	Severe: piping, excess sodium.	Deep to water	Percs slowly, slope, excess sodium.	Percs slowly	Excess sodium, percs slowly.
WxC*:						
Williams	Moderate: seepage, slope.	Moderate: piping, large stones.	Deep to water	Percs slowly, slope.	Large stones, percs slowly.	Large stones, percs slowly.
Vida	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Slope	Favorable	Favorable.
Bowbells	Moderate: seepage.	Moderate: piping.	Deep to water	Flooding	Erodes easily	Erodes easily.
WzD*:						
Williams	Severe: slope.	Moderate: piping.	Deep to water	Percs slowly, slope.	Slope, erodes easily.	Slope, erodes easily, percs slowly.
Zahill	Severe: slope.	Severe: piping.	Deep to water	Slope, erodes easily.	Slope, erodes easily.	Slope, erodes easily.
Bowbells	Moderate: seepage.	Moderate: piping.	Deep to water	Flooding	Erodes easily	Erodes easily.
ZaE Zahill	Severe: slope.	Severe: piping.	Deep to water	Slope, erodes easily.	Slope, erodes easily.	Slope, erodes easily.
ZcE Zahill	Severe: slope.	Moderate: piping.	Deep to water	Slope	Slope	Slope.
ZlD*:						
Zahill	Severe: slope.	Severe: piping.	Deep to water	Slope, erodes easily.	Slope, erodes easily.	Slope, erodes easily.
La Prairie	Moderate: seepage.	Moderate: piping, wetness.	Deep to water	Flooding	Favorable	Favorable.

See footnote at end of table.

TABLE 12.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
ZmC*:						
Zahl	Moderate: slope.	Moderate: piping.	Deep to water	Percs slowly, slope.	Erodes easily, percs slowly.	Erodes easily, percs slowly.
Max	Moderate: slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
ZmD*:						
Zahl	Severe: slope.	Moderate: piping.	Deep to water	Percs slowly, slope.	Slope, erodes easily, percs slowly.	Slope, erodes easily, percs slowly.
Max	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 13.--ENGINEERING INDEX PROPERTIES

[The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated]

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
Bb Bowbells	0-11	Loam	CL, ML, CL-ML	A-4, A-6	0-5	95-100	90-100	85-95	60-90	25-40	5-15
	11-27	Loam, clay loam	CL	A-6, A-7	0-5	95-100	90-100	80-95	60-80	30-45	10-20
	27-60	Loam, clay loam	CL	A-6, A-7	0-5	95-100	90-100	80-95	60-80	30-45	10-20
BoA Bowdle	0-7	Loam	ML, CL	A-6, A-4	0	100	95-100	85-95	55-80	30-40	7-15
	7-21	Loam, clay loam	CL, CL	A-4, A-6	0	95-100	95-100	80-95	55-75	30-40	8-15
	21-24	Gravelly loam, gravelly sandy loam, loam.	SM, SM-SC, ML, CL-ML	A-2, A-4	0	90-100	80-100	60-95	30-60	25-35	5-10
	24-60	Gravelly sand, gravelly loamy sand.	SM, SW-SM, SP-SM	A-1, A-2	0-5	60-95	50-85	25-50	5-30	<30	NP-5
BrA*, BrB*: Bryant	0-6	Silt loam	ML, CL, CL-ML	A-6, A-4	0	100	100	85-100	70-100	25-40	3-15
	6-17	Clay loam, silt loam, silty clay loam.	CL, ML, CL-ML	A-6, A-4	0	100	100	85-100	70-100	25-40	3-15
	17-60	Silty clay loam, loam, silt loam.	CL, ML, CL-ML	A-6, A-4	0	100	100	85-100	70-100	25-40	3-15
Grassna	0-7	Silt loam	CL, CL-ML	A-4, A-6, A-7	0	100	100	90-100	70-90	25-45	5-20
	7-60	Silt loam, silty clay loam.	ML, CL, CL-ML	A-4, A-6, A-7	0	100	100	90-100	70-95	25-45	5-20
Ha Harriet	0-3	Silt loam	CL, CL-ML	A-4, A-6	0	100	100	85-100	60-90	25-40	5-20
	3-24	Clay loam, silty clay loam, silty clay.	CL, CH	A-7, A-6	0	100	100	90-100	70-100	35-70	20-40
	24-60	Stratified very fine sandy loam to silty clay.	CL, CL-ML, CH	A-4, A-6, A-7	0	100	100	90-100	60-100	20-65	5-40
He Heil	0-2	Silt loam	CL	A-6, A-7	0	100	100	90-100	70-95	25-50	10-25
	2-45	Silty clay, clay, silty clay loam.	CH	A-7	0	100	100	90-100	75-95	50-70	25-45
	45-60	Silty clay, clay loam, loam.	CH, CL	A-7, A-6	0	100	100	85-100	60-95	25-60	11-45
La, Lb La Prairie	0-15	Loam	CL-ML, CL	A-4, A-6	0	100	100	85-100	70-80	25-40	5-15
	15-31	Silt loam, loam, silty clay loam.	CL-ML, CL	A-4, A-6, A-7	0	100	100	85-95	70-80	25-45	5-25
	31-60	Silt loam, loam, silty clay loam.	CL-ML, CL	A-4, A-6, A-7	0	100	95-100	85-100	60-80	25-45	5-25
LeA, LeB Lehr	0-5	Loam	ML, CL, CL-ML	A-4, A-6	0	95-100	95-100	85-95	60-80	20-40	3-15
	5-15	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	95-100	95-100	85-95	60-75	25-40	5-15
	15-60	Gravelly loamy sand, gravelly sand.	SM, SP, GM, GP	A-1	0-5	40-70	25-50	10-35	2-15	---	NP
MaA Manning	0-7	Sandy loam	SM	A-2, A-4	0	95-100	95-100	60-85	30-50	---	NP
	7-17	Sandy loam, fine sandy loam, loam.	SM, ML, CL, SC	A-2, A-4, A-6	0-3	85-100	80-100	60-95	30-70	<35	NP-15
	17-60	Loamy sand, gravelly loamy sand, gravelly sand.	GM, SM, GP-GM, SP-SM	A-1, A-2	0-5	40-75	25-65	10-40	5-35	---	NP

See footnote at end of table.

TABLE 13.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
MbA--------------	0-4	Loam-------------	ML, CL-ML	A-6, A-4	0	95-100	90-100	75-90	50-75	25-40	5-14
Manning Variant	4-37	Gravelly sand, gravelly loamy sand.	SM, SW-SM, SM-SC	A-2, A-1	0	90-100	50-75	15-50	5-30	<25	NP-5
	37-60	Clay loam, loam	CL	A-6, A-7	0-5	95-100	95-100	80-95	60-80	30-45	10-20
MdA*:											
Max-------------	0-14	Loam-------------	ML, CL, CL-ML	A-4, A-6, A-7	0-3	95-100	95-100	85-95	60-75	25-45	3-23
	14-60	Loam, clay loam	ML, CL, CL-ML	A-4, A-6, A-7	0-3	95-100	95-100	85-100	60-80	25-45	3-23
Arnegard---------	0-8	Loam-------------	CL-ML, CL	A-4, A-6	0	100	100	90-100	60-95	20-35	5-20
	8-23	Loam, silt loam, clay loam.	CL	A-6	0	100	100	90-100	60-95	25-40	12-25
	23-60	Loam, clay loam, fine sandy loam.	SM, ML, CL, SC	A-4, A-6	0	100	100	75-95	40-80	15-40	NP-15
MmB*:											
Max-------------	0-14	Loam-------------	ML, CL, CL-ML	A-4, A-6, A-7	0-3	95-100	95-100	85-95	60-75	25-45	3-23
	14-60	Loam, clay loam	ML, CL, CL-ML	A-4, A-6, A-7	0-3	95-100	95-100	85-100	60-80	25-45	3-23
Arnegard---------	0-8	Loam-------------	CL-ML, CL	A-4, A-6	0	100	100	90-100	60-95	20-35	5-20
	8-23	Loam, silt loam, clay loam.	CL	A-6	0	100	100	90-100	60-95	25-40	12-25
	23-60	Loam, clay loam, fine sandy loam.	SM, ML, CL, SC	A-4, A-6	0	100	100	75-95	40-80	15-40	NP-15
Zahl-------------	0-6	Loam-------------	CL	A-6	0-1	95-100	95-100	80-95	55-75	25-40	10-20
	6-60	Clay loam, loam	CL	A-6	0-1	95-100	90-100	80-95	60-80	25-40	10-20
MnB*:											
Max-------------	0-14	Loam-------------	ML, CL, CL-ML	A-4, A-6, A-7	0-3	95-100	95-100	85-95	60-75	25-45	3-23
	14-60	Loam, clay loam	ML, CL, CL-ML	A-4, A-6, A-7	0-3	95-100	95-100	85-100	60-80	25-45	3-23
Niobell----------	0-12	Loam-------------	ML, CL, CL-ML	A-4, A-6	0	95-100	95-100	85-95	60-75	25-40	3-18
	12-26	Clay loam, loam	CL, CH	A-6, A-7	0-1	95-100	95-100	90-100	60-80	30-60	15-35
	26-60	Loam, clay loam	ML, CL, CL-ML	A-4, A-6	0-1	95-100	95-100	85-95	60-75	25-40	5-20
Noonan-----------	0-8	Loam-------------	CL, CL-ML	A-4, A-6	0-1	95-100	95-100	80-95	55-75	20-40	5-25
	8-19	Clay loam--------	CL, CH	A-6, A-7	0-1	95-100	95-100	85-95	65-80	25-60	10-35
	19-60	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-1	95-100	95-100	80-95	60-80	25-50	5-25
MoA, MoB---------	0-6	Silty clay loam	CL, ML	A-6, A-7	0	100	100	95-100	85-100	35-50	10-25
Mondamin	6-27	Silty clay, silty clay loam.	CH, CL	A-7	0	100	100	95-100	90-100	40-60	15-35
	27-60	Stratified fine sand to silty clay loam.	CL, CH	A-7	0	100	95-100	90-100	65-100	40-65	20-40
NaA*:											
Niobell----------	0-12	Loam-------------	ML, CL, CL-ML	A-4, A-6	0	95-100	95-100	85-95	60-75	25-40	3-18
	12-26	Clay loam, loam	CL, CH	A-6, A-7	0-1	95-100	95-100	90-100	60-80	30-60	15-35
	26-60	Loam, clay loam	ML, CL, CL-ML	A-4, A-6	0-1	95-100	95-100	85-95	60-75	25-40	3-18
Noonan-----------	0-8	Loam-------------	CL, CL-ML	A-4, A-6	0-1	95-100	95-100	80-95	55-75	20-40	5-25
	8-19	Clay loam--------	CL, CH	A-6, A-7	0-1	95-100	95-100	85-95	65-80	25-60	10-35
	19-60	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-1	95-100	95-100	80-95	60-80	25-50	5-25

See footnote at end of table.

TABLE 13.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
NbA*:											
Niobell----------	0-12	Loam--------------	ML, CL, CL-ML	A-4, A-6	0	95-100	95-100	85-95	60-75	25-40	3-18
	12-26	Clay loam, loam	CL, CH	A-6, A-7	0-1	95-100	95-100	90-100	60-80	30-60	15-35
	26-60	Loam, clay loam	ML, CL, CL-ML	A-4, A-6	0-1	95-100	95-100	85-95	60-75	25-40	5-20
Noonan-----------	0-8	Loam--------------	CL, CL-ML	A-4, A-6	0-1	95-100	95-100	80-95	55-75	20-40	5-25
	8-19	Clay loam---------	CL, CH	A-6, A-7	0-1	95-100	95-100	85-95	65-80	25-60	10-35
	19-60	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-1	95-100	95-100	80-95	60-80	25-50	5-25
Max--------------	0-14	Loam--------------	ML, CL, CL-ML	A-4, A-6, A-7	0-3	95-100	95-100	85-95	60-75	25-45	3-23
	14-60	Loam, clay loam	ML, CL, CL-ML	A-4, A-6, A-7	0-3	95-100	95-100	85-100	60-80	25-45	3-23
Nn----------------- Nishon	0-7	Silt loam---------	CL-ML, CL	A-4, A-6	0	100	100	90-100	75-90	25-40	5-15
	7-32	Clay, silty clay	CL, CH	A-7	0	100	100	90-100	75-95	40-65	20-45
	32-60	Clay, silty clay, silty clay loam.	CL, CH	A-6, A-7	0	90-100	90-100	80-100	65-95	35-60	15-40
NoA*:											
Noonan-----------	0-8	Loam--------------	CL, CL-ML	A-4, A-6	0-1	95-100	95-100	80-95	55-75	20-40	5-25
	8-19	Clay loam---------	CL, CH	A-6, A-7	0-1	95-100	95-100	85-95	65-80	25-60	10-35
	19-60	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-1	95-100	95-100	80-95	60-80	25-50	5-25
Miranda----------	0-5	Loam--------------	CL-ML, CL, ML	A-4, A-6	0	100	100	85-95	60-85	25-40	5-15
	5-13	Loam, clay loam	CL, ML	A-6, A-7	0-5	95-100	95-100	85-95	50-80	30-50	10-20
	13-60	Loam, clay loam	CL, ML	A-6, A-7	0-5	95-100	95-100	85-95	60-80	30-50	10-20
Pa, Pp------------ Parnell	0-6	Silty clay loam	CL, CH	A-7	0	100	100	95-100	85-95	40-60	15-30
	6-50	Clay loam, silty clay loam, silty clay.	CL, CH	A-7	0	100	95-100	90-100	70-95	40-80	20-50
	50-60	Clay loam, silty clay loam, silty clay.	CL, CH	A-6, A-7	0	95-100	90-100	80-95	70-95	30-80	15-50
Pt*. Pits											
RaA*, RaB*:											
Raber------------	0-5	Clay loam---------	CL	A-4, A-6, A-7	0	100	100	90-100	70-90	30-50	9-22
	5-13	Clay loam, clay	CL, CH	A-6, A-7	0	100	100	90-100	70-95	35-60	11-35
	13-60	Clay loam, clay	CL, CH	A-6, A-7	0	100	100	90-100	70-90	30-60	11-35
Cavo-------------	0-5	Loam--------------	CL, CL-ML	A-4, A-6	0	100	95-100	85-100	60-85	25-40	5-20
	5-12	Clay loam, clay	CL, CH	A-7	0	100	95-100	90-100	70-95	40-65	15-35
	12-60	Clay loam, clay	CL, CH	A-7, A-6	0-5	95-100	95-100	85-100	60-95	36-55	15-30
Rh*:											
Ranslo-----------	0-10	Silt loam---------	CL, CL-ML, ML	A-4, A-6	0	100	100	90-100	70-90	25-40	3-15
	10-20	Silty clay, silty clay loam, clay loam.	CH, CL	A-7	0	100	100	95-100	75-90	40-60	20-35
	20-31	Clay loam, silty clay, silty clay loam.	CH	A-7	0	100	100	95-100	75-95	50-75	23-42
	31-60	Clay loam, silty clay loam, sandy clay loam.	CL, CH	A-6, A-7	0	100	100	85-100	50-90	35-55	12-28

See footnote at end of table.

TABLE 13.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
Rh*:											
Harriet----------	0-3	Silt loam---------	CL, CL-ML	A-4, A-6	0	100	100	85-100	60-90	25-40	5-20
	3-24	Clay loam, silty clay loam, silty clay.	CL, CH	A-7, A-6	0	100	100	90-100	70-100	35-70	20-40
	24-60	Stratified very fine sandy loam to silty clay.	CL, CL-ML, CH	A-4, A-6, A-7	0	100	100	90-100	60-100	20-65	5-40
TaA, TaB--------- Tally	0-8	Fine sandy loam	SM, ML, SM-SC, SC	A-4, A-2	0	90-100	80-100	60-100	30-55	20-30	NP-10
	8-24	Fine sandy loam, sandy loam.	SM, SM-SC, SC	A-4, A-2	0	90-100	80-100	60-100	25-50	15-25	NP-10
	24-30	Sandy loam, fine sandy loam, loamy fine sand.	SM	A-4, A-2	0	90-100	80-100	60-100	15-50	15-25	NP-5
	30-60	Loamy fine sand, loamy sand, sandy loam.	SM	A-2	0	90-100	80-100	60-85	15-35	---	NP
Tn*:											
Tonka------------	0-21	Silt loam---------	CL, CL-ML	A-4, A-6	0-2	100	95-100	90-100	70-90	20-40	5-25
	21-38	Silty clay loam, clay loam, clay.	CH, CL	A-6, A-7	0-2	100	95-100	90-100	75-95	35-55	15-35
	38-60	Silty clay loam, clay loam.	CL	A-6, A-7	0-3	100	95-100	90-100	70-90	30-50	10-30
Nishon-----------	0-7	Silt loam---------	CL-ML, CL	A-4, A-6	0	100	100	90-100	75-90	25-40	5-15
	7-32	Clay, silty clay	CL, CH	A-7	0	100	100	90-100	75-95	40-65	20-45
	32-60	Clay, silty clay, silty clay loam.	CL, CH	A-6, A-7	0	90-100	90-100	80-100	65-95	35-60	15-40
VaC*:											
Vida-------------	0-6	Very stony loam	CL	A-6	10-25	80-100	75-95	65-85	50-70	25-35	10-15
	6-18	Clay loam, loam	CL	A-6, A-7	0-10	90-100	85-100	70-95	50-85	30-45	10-25
	18-60	Clay loam, loam	CL	A-6, A-7	0-10	90-100	85-100	70-95	50-80	25-45	10-25
Williams---------	0-7	Very stony loam	CL, CL-ML	A-4, A-6, A-7	3-25	95-100	95-100	85-95	60-90	25-45	5-25
	7-30	Loam, clay loam	CL	A-6, A-7	0-20	95-100	95-100	80-95	60-80	30-50	10-30
	30-60	Loam, clay loam	CL	A-6, A-7	0-15	95-100	95-100	80-95	60-80	30-50	10-30
VdC*:											
Vida-------------	0-6	Loam--------------	CL-ML	A-4	0-10	90-100	85-95	70-90	55-75	20-30	5-10
	6-18	Clay loam, loam	CL	A-6, A-7	0-10	90-100	85-100	70-95	50-85	30-45	10-25
	18-60	Clay loam, loam	CL	A-6, A-7	0-10	90-100	85-100	70-95	50-80	25-45	10-25
Williams---------	0-7	Loam--------------	CL, ML	A-4, A-6, A-7	0-5	95-100	95-100	85-100	60-90	25-45	3-20
	7-30	Clay loam, loam	CL	A-6, A-7	0-5	95-100	95-100	80-100	60-80	30-50	10-30
	30-60	Clay loam, loam	CL	A-6, A-7	0-5	95-100	95-100	80-100	60-80	30-50	10-30
Bowbells---------	0-11	Loam--------------	CL, ML, CL-ML	A-4, A-6	0-5	95-100	90-100	85-95	60-90	25-40	5-15
	11-27	Loam, clay loam	CL	A-6, A-7	0-5	95-100	90-100	80-95	60-80	30-45	10-20
	27-60	Loam, clay loam	CL	A-6, A-7	0-5	95-100	90-100	80-95	60-80	30-45	10-20
WaD--------------- Wabek	0-8	Loam--------------	ML	A-4	0-1	90-100	90-100	75-90	50-70	25-40	NP-10
	8-14	Gravelly sandy loam, gravelly loam, gravelly coarse sandy loam.	SM, GM	A-2, A-4	0-1	50-100	50-95	50-65	20-40	---	NP
	14-60	Sand and gravel	GM, GP, SM, SP	A-1	0-1	25-75	10-60	5-35	0-25	---	NP

See footnote at end of table.

TABLE 13.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
WbC*:											
Wabek	0-8	Loam	ML	A-4	0-1	90-100	90-100	75-90	50-70	25-40	NP-10
	8-14	Gravelly sandy loam, gravelly loam, gravelly coarse sandy loam.	SM, GM	A-2, A-4	0-1	50-100	50-95	50-65	20-40	---	NP
	14-60	Sand and gravel	GM, GP, SM, SP	A-1	0-1	25-75	10-60	5-35	0-25	---	NP
Bowdle	0-7	Loam	ML, CL	A-6, A-4	0	100	95-100	85-95	55-80	30-40	7-15
	7-21	Loam, clay loam	CL, CL	A-4, A-6	0	95-100	95-100	80-95	55-75	30-40	8-15
	21-24	Gravelly loam, gravelly sandy loam, loam.	SM, SM-SC, ML, CL-ML	A-2, A-4	0	90-100	80-100	60-95	30-60	25-35	5-10
	24-60	Gravelly sand, gravelly loamy sand.	SM, SW-SM, SP-SM	A-1, A-2	0-5	60-95	50-85	25-50	5-30	<30	NP-5
WnA*:											
Williams	0-7	Loam	CL, ML	A-4, A-6, A-7	0-5	95-100	95-100	85-100	60-90	25-45	3-20
	7-30	Clay loam, loam	CL	A-6, A-7	0-5	95-100	95-100	80-100	60-80	30-50	10-30
	30-60	Clay loam, loam	CL	A-6, A-7	0-5	95-100	95-100	80-100	60-80	30-50	10-30
Bowbells	0-11	Loam	CL, ML, CL-ML	A-4, A-6	0-5	95-100	90-100	85-95	60-90	25-40	5-15
	11-27	Loam, clay loam	CL	A-6, A-7	0-5	95-100	90-100	80-95	60-80	30-45	10-20
	27-60	Loam, clay loam	CL	A-6, A-7	0-5	95-100	90-100	80-95	60-80	30-45	10-20
WnB*:											
Williams	0-7	Loam	CL, ML	A-4, A-6, A-7	0-5	95-100	95-100	85-100	60-90	25-45	3-20
	7-30	Clay loam, loam	CL	A-6, A-7	0-5	95-100	95-100	80-100	60-80	30-50	10-30
	30-60	Clay loam, loam	CL	A-6, A-7	0-5	95-100	95-100	80-100	60-80	30-50	10-30
Bowbells	0-11	Loam	CL, ML, CL-ML	A-4, A-6	0-5	95-100	90-100	85-95	60-90	25-40	5-15
	11-27	Loam, clay loam	CL	A-6, A-7	0-5	95-100	90-100	80-95	60-80	30-45	10-20
	27-60	Loam, clay loam	CL	A-6, A-7	0-5	95-100	90-100	80-95	60-80	30-45	10-20
WoA*, WoB*:											
Williams	0-7	Loam	CL, ML	A-4, A-6, A-7	0-5	95-100	95-100	85-100	60-90	25-45	3-20
	7-30	Clay loam, loam	CL	A-6, A-7	0-5	95-100	95-100	80-100	60-80	30-50	10-30
	30-60	Clay loam, loam	CL	A-6, A-7	0-5	95-100	95-100	80-100	60-80	30-50	10-30
Bowbells	0-11	Loam	CL, ML, CL-ML	A-4, A-6	0-5	95-100	90-100	85-95	60-90	25-40	5-15
	11-27	Loam, clay loam	CL	A-6, A-7	0-5	95-100	90-100	80-95	60-80	30-45	10-20
	27-60	Loam, clay loam	CL	A-6, A-7	0-5	95-100	90-100	80-95	60-80	30-45	10-20
Nishon	0-7	Silt loam	CL-ML, CL	A-4, A-6	0	100	100	90-100	75-90	25-40	5-15
	7-32	Clay, silty clay	CL, CH	A-7	0	100	100	90-100	75-95	40-65	20-45
	32-60	Clay, silty clay, silty clay loam.	CL, CH	A-6, A-7	0	90-100	90-100	80-100	65-95	35-60	15-40
WpA*, WpB*:											
Williams	0-7	Loam	CL, ML	A-4, A-6, A-7	0-5	95-100	95-100	85-100	60-90	25-45	3-20
	7-30	Clay loam, loam	CL	A-6, A-7	0-5	95-100	95-100	80-100	60-80	30-50	10-30
	30-60	Clay loam, loam	CL	A-6, A-7	0-5	95-100	95-100	80-100	60-80	30-50	10-30
Bowbells	0-11	Loam	CL, ML, CL-ML	A-4, A-6	0-5	95-100	90-100	85-95	60-90	25-40	5-15
	11-27	Loam, clay loam	CL	A-6, A-7	0-5	95-100	90-100	80-95	60-80	30-45	10-20
	27-60	Loam, clay loam	CL	A-6, A-7	0-5	95-100	90-100	80-95	60-80	30-45	10-20

See footnote at end of table.

TABLE 13.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
WpA*, WpB*:											
Noonan----------	0-8	Loam--------------	CL, CL-ML	A-4, A-6	0-1	95-100	95-100	80-95	55-75	20-40	5-25
	8-19	Clay loam---------	CL, CH	A-6, A-7	0-1	95-100	95-100	85-95	65-80	25-60	10-35
	19-60	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-1	95-100	95-100	80-95	60-80	25-50	5-25
WtC*:											
Williams--------	0-7	Loam--------------	CL, ML	A-4, A-6, A-7	0-5	95-100	95-100	85-100	60-90	25-45	3-20
	7-30	Clay loam, loam	CL	A-6, A-7	0-5	95-100	95-100	80-100	60-80	30-50	10-30
	30-60	Clay loam, loam	CL	A-6, A-7	0-5	95-100	95-100	80-100	60-80	30-50	10-30
Bowbells--------	0-11	Loam--------------	CL, ML, CL-ML	A-4, A-6	0-5	95-100	90-100	85-95	60-90	25-40	5-15
	11-27	Loam, clay loam	CL	A-6, A-7	0-5	95-100	90-100	80-95	60-80	30-45	10-20
	27-60	Loam, clay loam	CL	A-6, A-7	0-5	95-100	90-100	80-95	60-80	30-45	10-20
Parnell---------	0-6	Silty clay loam	CL, CH	A-7	0	100	100	95-100	85-95	40-60	15-30
	6-50	Clay loam, silty clay loam, silty clay.	CL, CH	A-7	0	100	95-100	90-100	70-95	40-80	20-50
	50-60	Clay loam, silty clay loam, silty clay.	CL, CH	A-6, A-7	0	95-100	90-100	80-95	70-95	30-80	15-50
WvB*:											
Williams--------	0-7	Loam--------------	CL, ML	A-4, A-6, A-7	0-5	95-100	95-100	85-100	60-90	25-45	3-20
	7-30	Clay loam, loam	CL	A-6, A-7	0-5	95-100	95-100	80-100	60-80	30-50	10-30
	30-60	Clay loam, loam	CL	A-6, A-7	0-5	95-100	95-100	80-100	60-80	30-50	10-30
Bowbells--------	0-11	Loam--------------	CL, ML, CL-ML	A-4, A-6	0-5	95-100	90-100	85-95	60-90	25-40	5-15
	11-27	Loam, clay loam	CL	A-6, A-7	0-5	95-100	90-100	80-95	60-80	30-45	10-20
	27-60	Loam, clay loam	CL	A-6, A-7	0-5	95-100	90-100	80-95	60-80	30-45	10-20
Vida------------	0-6	Loam--------------	CL-ML	A-4	0-10	90-100	85-95	70-90	55-75	20-30	5-10
	6-18	Clay loam, loam	CL	A-6, A-7	0-10	90-100	85-100	70-95	50-85	30-45	10-25
	18-60	Clay loam, loam	CL	A-6, A-7	0-10	90-100	85-100	70-95	50-80	25-45	10-25
WwB*:											
Williams--------	0-7	Loam--------------	CL, ML	A-4, A-6, A-7	0-5	95-100	95-100	85-100	60-90	25-45	3-20
	7-30	Clay loam, loam	CL	A-6, A-7	0-5	95-100	95-100	80-100	60-80	30-50	10-30
	30-60	Clay loam, loam	CL	A-6, A-7	0-5	95-100	95-100	80-100	60-80	30-50	10-30
Niobell---------	0-12	Loam--------------	ML, CL, CL-ML	A-4, A-6	0	95-100	95-100	85-95	60-75	25-40	3-18
	12-26	Clay loam, loam	CL, CH	A-6, A-7	0-1	95-100	95-100	90-100	60-80	30-60	15-35
	26-60	Loam, clay loam	ML, CL, CL-ML	A-4, A-6	0-1	95-100	95-100	85-95	60-75	25-40	5-20
Noonan----------	0-8	Loam--------------	CL, CL-ML	A-4, A-6	0-1	95-100	95-100	80-95	55-75	20-40	5-25
	8-19	Clay loam---------	CL, CH	A-6, A-7	0-1	95-100	95-100	85-95	65-80	25-60	10-35
	19-60	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-1	95-100	95-100	80-95	60-80	25-50	5-25
WxC*:											
Williams--------	0-7	Stony loam-------	CL, CL-ML	A-4, A-6, A-7	3-25	95-100	95-100	85-100	60-90	25-45	5-25
	7-30	Loam, clay loam	CL	A-6, A-7	0-20	95-100	95-100	80-95	60-80	30-50	10-30
	30-60	Loam, clay loam	CL	A-6, A-7	0-15	95-100	95-100	80-95	60-80	30-50	10-30
Vida------------	0-6	Stony loam-------	CL-ML, SM-SC	A-4	10-25	80-100	75-95	60-85	45-65	20-30	5-10
	6-18	Clay loam, loam	CL	A-6, A-7	0-10	90-100	85-100	70-95	50-85	30-45	10-25
	18-60	Clay loam, loam	CL	A-6, A-7	0-10	90-100	85-100	70-95	50-80	25-45	10-25

See footnote at end of table.

TABLE 13.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
WxC*:											
Bowbells	0-11	Loam	CL, ML, CL-ML	A-4, A-6	0-5	95-100	90-100	85-95	60-90	25-40	5-15
	11-27	Loam, clay loam	CL	A-6, A-7	0-5	95-100	90-100	80-95	60-80	30-45	10-20
	27-60	Loam, clay loam	CL	A-6, A-7	0-5	95-100	90-100	80-95	60-80	30-45	10-20
WzD*:											
Williams	0-7	Loam	CL, ML	A-4, A-6, A-7	0-5	95-100	95-100	85-100	60-90	25-45	3-20
	7-30	Clay loam, loam	CL	A-6, A-7	0-5	95-100	95-100	80-100	60-80	30-50	10-30
	30-60	Clay loam, loam	CL	A-6, A-7	0-5	95-100	95-100	80-100	60-80	30-50	10-30
Zahill	0-3	Loam	CL-ML, ML	A-4	0-10	90-100	85-95	80-90	60-75	20-30	NP-10
	3-60	Clay loam, loam	CL, CL-ML	A-4, A-6, A-7	0-10	90-100	90-100	80-95	60-80	25-45	5-25
Bowbells	0-11	Loam	CL, ML, CL-ML	A-4, A-6	0-5	95-100	90-100	85-95	60-90	25-40	5-15
	11-27	Loam, clay loam	CL	A-6, A-7	0-5	95-100	90-100	80-95	60-80	30-45	10-20
	27-60	Loam, clay loam	CL	A-6, A-7	0-5	95-100	90-100	80-95	60-80	30-45	10-20
ZaE Zahill	0-3	Loam	CL-ML, ML	A-4	0-10	90-100	85-95	80-90	60-75	20-30	NP-10
	3-60	Clay loam, loam	CL, CL-ML	A-4, A-6, A-7	0-10	90-100	90-100	80-95	60-80	25-45	5-25
ZcE Zahill	0-3	Very stony loam	CL, CL-ML	A-6, A-4	5-25	90-100	90-100	80-90	60-80	25-40	5-15
	3-60	Clay loam, loam	CL	A-6, A-7	0-10	90-100	90-100	80-95	60-80	30-45	10-25
ZlD*:											
Zahill	0-3	Loam	CL-ML, ML	A-4	0-10	90-100	85-95	80-90	60-75	20-30	NP-10
	3-60	Clay loam, loam	CL, CL-ML	A-4, A-6, A-7	0-10	90-100	90-100	80-95	60-80	25-45	5-25
La Prairie	0-15	Loam	CL-ML, CL	A-4, A-6	0	100	100	85-95	70-80	25-40	5-15
	15-31	Silt loam, loam, silty clay loam.	CL-ML, CL	A-4, A-6, A-7	0	100	100	85-95	70-80	25-45	5-25
	31-60	Silt loam, loam, silty clay loam.	CL-ML, CL	A-4, A-6, A-7	0	100	100	85-95	70-80	25-45	5-25
ZmC*, ZmD*:											
Zahl	0-6	Loam	CL	A-6	0-1	95-100	95-100	80-95	55-75	25-40	10-20
	6-60	Clay loam, loam	CL	A-6	0-1	95-100	90-100	80-95	60-80	25-40	10-20
Max	0-14	Loam	ML, CL, CL-ML	A-4, A-6, A-7	0-3	95-100	95-100	85-95	60-75	25-45	3-23
	14-60	Loam, clay loam	ML, CL, CL-ML	A-4, A-6, A-7	0-3	95-100	95-100	85-100	60-80	25-45	3-23

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* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

[The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" and "Organic matter" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated]

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group	Organic matter
	In	In/hr	In/in	pH	Mmhos/cm					Pct
Bb----------------	0-11	0.6-2.0	0.17-0.24	6.1-7.3	<2	Low----------	0.28	5	6	4-6
Bowbells	11-27	0.6-2.0	0.16-0.22	6.1-7.3	<2	Moderate-----	0.28			
	27-60	0.2-0.6	0.14-0.18	7.9-8.4	<2	Moderate-----	0.37			
BoA---------------	0-7	0.6-2.0	0.18-0.20	6.1-7.3	<2	Low----------	0.28	4	6	3-5
Bowdle	7-21	0.6-2.0	0.18-0.20	6.1-7.3	<2	Low----------	0.28			
	21-24	0.6-2.0	0.15-0.18	7.4-8.4	<2	Low----------	0.28			
	24-60	6.0-20	0.03-0.06	7.4-8.4	<2	Low----------	0.10			
BrA*, BrB*:										
Bryant-----------	0-6	0.6-2.0	0.18-0.20	6.1-7.3	<2	Low----------	0.32	5	6	2-4
	6-17	0.6-2.0	0.19-0.22	6.6-7.8	<2	Low----------	0.43			
	17-60	0.6-2.0	0.17-0.20	7.4-8.4	<2	Low----------	0.43			
Grassna----------	0-7	0.6-2.0	0.22-0.24	6.1-7.3	<2	Moderate-----	0.32	5	6	4-6
	7-60	0.6-2.0	0.16-0.22	6.6-8.4	<2	Moderate-----	0.32			
Ha----------------	0-3	0.06-0.2	0.20-0.24	6.6-8.4	<2	Moderate-----	0.37	3	6	3-6
Harriet	3-24	<0.06	0.10-0.15	>7.3	4-16	High---------	0.37			
	24-60	0.06-0.2	0.10-0.15	>7.8	4-16	Moderate-----	0.37			
He----------------	0-2	<0.06	0.15-0.24	5.6-7.3	<2	Moderate-----	0.28	3	7	3-6
Heil	2-45	<0.06	0.13-0.18	6.6-9.0	4-16	High---------	0.28			
	45-60	<0.06	0.13-0.18	7.9-9.0	4-16	High---------	0.28			
La, Lb------------	0-15	0.6-2.0	0.17-0.22	6.6-8.4	<2	Low----------	0.28	5	6	2-6
La Prairie	15-31	0.6-2.0	0.17-0.22	6.6-8.4	<2	Moderate-----	0.28			
	31-60	0.6-2.0	0.15-0.22	6.6-8.4	<2	Moderate-----	0.28			
LeA, LeB----------	0-5	2.0-6.0	0.17-0.22	6.6-7.3	<2	Low----------	0.28	3	5	1-3
Lehr	5-15	2.0-6.0	0.17-0.20	6.6-8.4	<2	Moderate-----	0.28			
	15-60	>6.0	0.02-0.04	7.4-8.4	<2	Low----------	0.10			
MaA---------------	0-7	2.0-6.0	0.13-0.18	6.6-7.3	<2	Low----------	0.20	4	3	2-5
Manning	7-17	2.0-6.0	0.12-0.20	6.6-8.4	<2	Low----------	0.20			
	17-60	>20	0.02-0.08	7.4-8.4	<2	Low----------	0.10			
MbA---------------	0-4	0.6-2.0	0.18-0.20	6.6-7.8	<2	Low----------	0.28	5	6	1-3
Manning Variant	4-37	6.0-20	0.05-0.08	6.6-8.4	<2	Low----------	0.17			
	37-60	0.06-0.6	0.17-0.20	7.4-8.4	<4	Moderate-----	0.37			
MdA*:										
Max--------------	0-14	0.6-2.0	0.20-0.22	6.6-7.8	<2	Moderate-----	0.28	5	6	3-6
	14-60	0.2-0.6	0.14-0.19	7.9-8.4	<2	Moderate-----	0.37			
Arnegard---------	0-8	0.6-2.0	0.18-0.22	6.1-7.3	<2	Moderate-----	0.28	5	6	3-6
	8-23	0.6-2.0	0.17-0.21	6.6-7.8	<2	Moderate-----	0.28			
	23-60	0.6-2.0	0.13-0.19	6.6-8.4	<2	Low----------	0.28			
MmB*:										
Max--------------	0-14	0.6-2.0	0.20-0.22	6.6-7.8	<2	Moderate-----	0.28	5	6	3-6
	14-60	0.2-0.6	0.14-0.19	7.9-8.4	<2	Moderate-----	0.37			
Arnegard---------	0-8	0.6-2.0	0.18-0.22	6.1-7.3	<2	Moderate-----	0.28	5	6	3-6
	8-23	0.6-2.0	0.17-0.21	6.6-7.8	<2	Moderate-----	0.28			
	23-60	0.6-2.0	0.13-0.19	6.6-8.4	<2	Low----------	0.28			
Zahl-------------	0-6	0.6-2.0	0.17-0.22	6.6-7.8	<2	Moderate-----	0.28	5	4L	1-3
	6-60	0.06-0.6	0.15-0.19	7.4-8.4	<2	Moderate-----	0.37			
MnB*:										
Max--------------	0-14	0.6-2.0	0.20-0.22	6.6-7.8	<2	Moderate-----	0.28	5	6	3-6
	14-60	0.2-0.6	0.14-0.19	7.9-8.4	<2	Moderate-----	0.37			

See footnote at end of table.

TABLE 14.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
							K	T		
	In	In/hr	In/in	pH	Mmhos/cm					Pct
MnB*:										
Niobell----------	0-12	0.6-2.0	0.20-0.22	6.1-7.3	<2	Moderate----	0.32	3	6	2-6
	12-26	0.06-0.2	0.15-0.19	7.4-8.4	<2	High--------	0.32			
	26-60	0.2-0.6	0.15-0.19	7.9-9.0	2-8	Moderate----	0.32			
Noonan-----------	0-8	0.6-2.0	0.20-0.22	6.1-7.3	<2	Moderate----	0.32	3	6	2-6
	8-19	0.06-0.2	0.12-0.14	6.6-9.0	<2	High--------	0.32			
	19-60	0.06-0.2	0.10-0.14	7.9-9.0	2-8	Moderate----	0.32			
MoA, MoB--------- Mondamin	0-6	0.2-0.6	0.19-0.22	6.1-7.3	<2	Moderate----	0.37	5	7	2-4
	6-27	0.06-0.6	0.13-0.18	6.6-8.4	<2	High--------	0.37			
	27-60	0.06-0.6	0.17-0.20	7.4-8.4	<2	Moderate----	0.37			
NaA*:										
Niobell----------	0-12	0.6-2.0	0.20-0.22	6.1-7.3	<2	Moderate----	0.32	3	6	2-6
	12-26	0.06-0.2	0.15-0.19	7.4-8.4	<2	High--------	0.32			
	26-60	0.2-0.6	0.15-0.19	7.9-9.0	2-8	Moderate----	0.32			
Noonan-----------	0-8	0.6-2.0	0.20-0.22	6.1-7.3	<2	Moderate----	0.32	3	6	2-6
	8-19	0.06-0.2	0.12-0.14	6.6-9.0	<2	High--------	0.32			
	19-60	0.06-0.2	0.10-0.14	7.9-9.0	2-8	Moderate----	0.32			
NbA*:										
Niobell----------	0-12	0.6-2.0	0.20-0.22	6.1-7.3	<2	Moderate----	0.32	3	6	2-6
	12-26	0.06-0.2	0.15-0.19	7.4-8.4	<2	High--------	0.32			
	26-60	0.2-0.6	0.15-0.19	7.9-9.0	2-8	Moderate----	0.32			
Noonan-----------	0-8	0.6-2.0	0.20-0.22	6.1-7.3	<2	Moderate----	0.32	3	6	2-6
	8-19	0.06-0.2	0.12-0.14	6.6-9.0	<2	High--------	0.32			
	19-60	0.06-0.2	0.10-0.14	7.9-9.0	2-8	Moderate----	0.32			
Max--------------	0-14	0.6-2.0	0.20-0.22	6.6-7.8	<2	Moderate----	0.28	5	6	3-6
	14-60	0.2-0.6	0.14-0.19	7.9-8.4	<2	Moderate----	0.37			
Nn--------------- Nishon	0-7	0.6-2.0	0.18-0.22	6.1-7.8	<2	Low---------	0.43	5	6	.5-1
	7-32	0.06-0.2	0.14-0.18	6.6-9.0	<2	High--------	0.32			
	32-60	0.06-0.2	0.14-0.18	7.4-9.0	2-4	High--------	0.32			
NoA*:										
Noonan-----------	0-8	0.6-2.0	0.20-0.22	6.1-7.3	<2	Moderate----	0.32	3	6	2-6
	8-19	0.06-0.2	0.12-0.14	6.6-9.0	<2	High--------	0.32			
	19-60	0.06-0.2	0.10-0.14	7.9-9.0	2-8	Moderate----	0.32			
Miranda----------	0-5	0.6-2.0	0.18-0.20	6.1-7.3	<2	Low---------	0.32	1	6	1-3
	5-13	<0.06	0.14-0.18	6.6-8.4	2-8	Moderate----	0.32			
	13-60	<0.06	0.13-0.17	7.9-9.0	4-16	Moderate----	0.32			
Pa, Pp----------- Parnell	0-6	0.2-0.6	0.18-0.22	6.1-7.8	<2	Moderate----	0.28	5	7	6-10
	6-50	0.06-0.2	0.13-0.19	6.6-7.8	<2	High--------	0.28			
	50-60	0.06-0.2	0.11-0.19	6.6-8.4	<2	High--------	0.28			
Pt*. Pits										
RaA*, RaB*:										
Raber------------	0-5	0.2-2.0	0.19-0.22	6.1-7.3	<2	Moderate----	0.28	5	6	2-4
	5-13	0.06-0.6	0.13-0.19	6.6-7.8	<2	High--------	0.28			
	13-60	0.06-0.6	0.11-0.20	7.4-8.4	<4	High--------	0.37			
Cavo-------------	0-5	0.6-2.0	0.18-0.22	6.1-7.3	<2	Low---------	0.32	3	6	1-3
	5-12	<0.2	0.10-0.15	7.4-8.4	2-8	High--------	0.32			
	12-60	0.06-0.6	0.08-0.14	7.9-9.0	4-16	Moderate----	0.32			
Rh*:										
Ranslo-----------	0-10	0.6-2.0	0.19-0.22	5.6-7.3	<2	Low---------	0.37	5	6	4-7
	10-20	0.06-0.2	0.13-0.16	6.6-8.4	2-4	High--------	0.28			
	20-31	0.06-0.2	0.08-0.13	7.4-8.4	2-8	High--------	0.28			
	31-60	0.2-0.6	0.14-0.17	7.4-9.0	2-8	High--------	0.28			

See footnote at end of table.

TABLE 14.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
							K	T		
	In	In/hr	In/in	pH	Mmhos/cm					Pct
Rh*:										
Harriet----------	0-3	0.06-0.2	0.20-0.24	6.6-8.4	<2	Moderate----	0.37	3	6	3-6
	3-24	<0.06	0.10-0.15	>7.3	4-16	High--------	0.37			
	24-60	0.06-0.2	0.10-0.15	>7.8	4-16	Moderate----	0.37			
TaA, TaB---------- Tally	0-8	2.0-6.0	0.12-0.16	6.1-7.8	<2	Low---------	0.20	5	3	1-3
	8-24	2.0-6.0	0.12-0.16	6.6-8.4	<2	Low---------	0.20			
	24-30	2.0-6.0	0.10-0.13	7.4-8.4	<2	Low---------	0.20			
	30-60	6.0-20	0.06-0.10	7.4-8.4	<2	Low---------	0.17			
Tn*:										
Tonka------------	0-21	0.6-2.0	0.18-0.23	5.6-7.3	<2	Low---------	0.32	5	6	5-10
	21-38	0.06-0.2	0.14-0.19	5.6-7.3	<2	High--------	0.43			
	38-60	0.2-0.6	0.14-0.19	6.6-9.0	<2	Moderate----	0.43			
Nishon-----------	0-7	0.6-2.0	0.18-0.22	6.1-7.8	<2	Low---------	0.43	5	6	.5-1
	7-32	0.06-0.2	0.14-0.18	6.6-9.0	<2	High--------	0.32			
	32-60	0.06-0.2	0.14-0.18	7.4-9.0	2-4	High--------	0.32			
VaC*:										
Vida-------------	0-6	0.6-2.0	0.11-0.15	6.6-8.4	<2	Moderate----	0.28	5	6	1-3
	6-18	0.6-2.0	0.14-0.18	6.6-8.4	<2	Moderate----	0.32			
	18-60	0.2-0.6	0.14-0.18	7.9-9.0	<2	Moderate----	0.32			
Williams---------	0-7	0.6-2.0	0.17-0.24	6.6-7.3	<2	Low---------	0.20	5	8	2-7
	7-30	0.6-2.0	0.16-0.20	6.6-7.8	<2	Moderate----	0.32			
	30-60	0.06-0.6	0.15-0.18	7.9-8.4	<2	Moderate----	0.32			
VdC*:										
Vida-------------	0-6	0.6-2.0	0.16-0.20	6.6-8.4	<2	Low---------	0.37	5	6	1-3
	6-18	0.6-2.0	0.14-0.18	6.6-8.4	<2	Moderate----	0.32			
	18-60	0.2-0.6	0.14-0.18	7.9-9.0	<2	Moderate----	0.32			
Williams---------	0-7	0.6-2.0	0.17-0.24	6.6-7.3	<2	Low---------	0.28	5	6	2-7
	7-30	0.6-2.0	0.16-0.20	6.6-7.8	<2	Moderate----	0.28			
	30-60	0.06-0.6	0.15-0.18	7.9-8.4	<2	Moderate----	0.37			
Bowbells---------	0-11	0.6-2.0	0.17-0.24	6.1-7.3	<2	Low---------	0.28	5	6	4-6
	11-27	0.6-2.0	0.16-0.22	6.1-7.3	<2	Moderate----	0.28			
	27-60	0.2-0.6	0.14-0.18	7.9-8.4	<2	Moderate----	0.37			
WaD-------------- Wabek	0-8	2.0-6.0	0.20-0.22	6.6-7.8	<2	Low---------	0.28	2	5	1-2
	8-14	2.0-6.0	0.11-0.15	6.6-7.8	<2	Low---------	0.10			
	14-60	>20	0.02-0.04	7.4-7.8	<2	Low---------	0.10			
WbC*:										
Wabek------------	0-8	2.0-6.0	0.20-0.22	6.6-7.8	<2	Low---------	0.28	2	5	1-2
	8-14	2.0-6.0	0.11-0.15	6.6-7.8	<2	Low---------	0.10			
	14-60	>20	0.02-0.04	7.4-7.8	<2	Low---------	0.10			
Bowdle-----------	0-7	0.6-2.0	0.18-0.20	6.1-7.3	<2	Low---------	0.28	4	6	3-5
	7-21	0.6-2.0	0.18-0.20	6.1-7.3	<2	Low---------	0.28			
	21-24	0.6-2.0	0.15-0.18	7.4-8.4	<2	Low---------	0.28			
	24-60	6.0-20	0.03-0.06	7.4-8.4	<2	Low---------	0.10			
WnA*, WnB*:										
Williams---------	0-7	0.6-2.0	0.17-0.24	6.6-7.3	<2	Low---------	0.28	5	6	2-7
	7-30	0.6-2.0	0.16-0.20	6.6-7.8	<2	Moderate----	0.28			
	30-60	0.06-0.6	0.15-0.18	7.9-8.4	<2	Moderate----	0.37			
Bowbells---------	0-11	0.6-2.0	0.17-0.24	6.1-7.3	<2	Low---------	0.28	5	6	4-6
	11-27	0.6-2.0	0.16-0.22	6.1-7.3	<2	Moderate----	0.28			
	27-60	0.2-0.6	0.14-0.18	7.9-8.4	<2	Moderate----	0.37			
WoA*, WoB*:										
Williams---------	0-7	0.6-2.0	0.17-0.24	6.6-7.3	<2	Low---------	0.28	5	6	2-7
	7-30	0.6-2.0	0.16-0.20	6.6-7.8	<2	Moderate----	0.28			
	30-60	0.06-0.6	0.15-0.18	7.9-8.4	<2	Moderate----	0.37			

See footnote at end of table.

TABLE 14.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors		Wind erodi-bility group	Organic matter
							K	T		
	In	In/hr	In/in	pH	Mmhos/cm					Pct
WoA*, WoB*:										
Bowbells	0-11	0.6-2.0	0.17-0.24	6.1-7.3	<2	Low	0.28	5	6	4-6
	11-27	0.6-2.0	0.16-0.22	6.1-7.3	<2	Moderate	0.28			
	27-60	0.2-0.6	0.14-0.18	7.9-8.4	<2	Moderate	0.37			
Nishon	0-7	0.6-2.0	0.18-0.22	6.1-7.8	<2	Low	0.43	5	6	.5-1
	7-32	0.06-0.2	0.14-0.18	6.6-9.0	<2	High	0.32			
	32-60	0.06-0.2	0.14-0.18	7.4-9.0	2-4	High	0.32			
WpA*, WpB*:										
Williams	0-7	0.6-2.0	0.17-0.24	6.6-7.3	<2	Low	0.28	5	6	2-7
	7-30	0.6-2.0	0.16-0.20	6.6-7.8	<2	Moderate	0.28			
	30-60	0.06-0.6	0.15-0.18	7.9-8.4	<2	Moderate	0.37			
Bowbells	0-11	0.6-2.0	0.17-0.24	6.1-7.3	<2	Low	0.28	5	6	4-6
	11-27	0.6-2.0	0.16-0.22	6.1-7.3	<2	Moderate	0.28			
	27-60	0.2-0.6	0.14-0.18	7.9-8.4	<2	Moderate	0.37			
Noonan	0-8	0.6-2.0	0.20-0.22	6.1-7.3	<2	Moderate	0.32	3	6	2-6
	8-19	0.06-0.2	0.12-0.14	6.6-9.0	<2	High	0.32			
	19-60	0.06-0.2	0.10-0.14	7.9-9.0	2-8	Moderate	0.32			
WtC*:										
Williams	0-7	0.6-2.0	0.17-0.24	6.6-7.3	<2	Low	0.28	5	6	2-7
	7-30	0.6-2.0	0.16-0.20	6.6-7.8	<2	Moderate	0.28			
	30-60	0.06-0.6	0.15-0.18	7.9-8.4	<2	Moderate	0.37			
Bowbells	0-11	0.6-2.0	0.17-0.24	6.1-7.3	<2	Low	0.28	5	6	4-6
	11-27	0.6-2.0	0.16-0.22	6.1-7.3	<2	Moderate	0.28			
	27-60	0.2-0.6	0.14-0.18	7.9-8.4	<2	Moderate	0.37			
Parnell	0-6	0.2-0.6	0.18-0.22	6.1-7.8	<2	Moderate	0.28	5	7	6-10
	6-50	0.06-0.2	0.13-0.19	6.6-7.8	<2	High	0.28			
	50-60	0.06-0.2	0.11-0.19	6.6-8.4	<2	High	0.28			
WvB*:										
Williams	0-7	0.6-2.0	0.17-0.24	6.6-7.3	<2	Low	0.28	5	6	2-7
	7-30	0.6-2.0	0.16-0.20	6.6-7.8	<2	Moderate	0.28			
	30-60	0.06-0.6	0.15-0.18	7.9-8.4	<2	Moderate	0.37			
Bowbells	0-11	0.6-2.0	0.17-0.24	6.1-7.3	<2	Low	0.28	5	6	4-6
	11-27	0.6-2.0	0.16-0.22	6.1-7.3	<2	Moderate	0.28			
	27-60	0.2-0.6	0.14-0.18	7.9-8.4	<2	Moderate	0.37			
Vida	0-6	0.6-2.0	0.16-0.20	6.6-8.4	<2	Low	0.37	5	6	1-3
	6-18	0.6-2.0	0.14-0.18	6.6-8.4	<2	Moderate	0.32			
	18-60	0.2-0.6	0.14-0.18	7.9-9.0	<2	Moderate	0.32			
WwB*:										
Williams	0-7	0.6-2.0	0.17-0.24	6.6-7.3	<2	Low	0.28	5	6	2-7
	7-30	0.6-2.0	0.16-0.20	6.6-7.8	<2	Moderate	0.28			
	30-60	0.06-0.6	0.15-0.18	7.9-8.4	<2	Moderate	0.37			
Niobell	0-12	0.6-2.0	0.20-0.22	6.1-7.3	<2	Moderate	0.32	3	6	2-6
	12-26	0.06-0.2	0.15-0.19	7.4-8.4	<2	High	0.32			
	26-60	0.2-0.6	0.15-0.19	7.9-9.0	2-8	Moderate	0.32			
Noonan	0-8	0.6-2.0	0.20-0.22	6.1-7.3	<2	Moderate	0.32	3	6	2-6
	8-19	0.06-0.2	0.12-0.14	6.6-9.0	<2	High	0.32			
	19-60	0.06-0.2	0.10-0.14	7.9-9.0	2-8	Moderate	0.32			
WxC*:										
Williams	0-7	0.6-2.0	0.17-0.24	6.6-7.3	<2	Low	0.20	5	8	2-7
	7-30	0.6-2.0	0.16-0.20	6.6-7.8	<2	Moderate	0.32			
	30-60	0.06-0.6	0.15-0.18	7.9-8.4	<2	Moderate	0.32			

See footnote at end of table.

TABLE 14.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
							K	T		
	In	In/hr	In/in	pH	Mmhos/cm					Pct
WxC*:										
Vida------------	0-6	0.6-2.0	0.13-0.17	6.6-8.4	<2	Low----------	0.32	5	6	1-3
	6-18	0.6-2.0	0.14-0.18	6.6-8.4	<2	Moderate-----	0.32			
	18-60	0.2-0.6	0.14-0.18	7.9-9.0	<2	Moderate-----	0.32			
Bowbells---------	0-11	0.6-2.0	0.17-0.24	6.1-7.3	<2	Low----------	0.28	5	6	4-6
	11-27	0.6-2.0	0.16-0.22	6.1-7.3	<2	Moderate-----	0.28			
	27-60	0.2-0.6	0.14-0.18	7.9-8.4	<2	Moderate-----	0.37			
WzD*:										
Williams---------	0-7	0.6-2.0	0.17-0.24	6.6-7.3	<2	Low----------	0.28	5	6	2-7
	7-30	0.6-2.0	0.16-0.20	6.6-7.8	<2	Moderate-----	0.28			
	30-60	0.06-0.6	0.15-0.18	7.9-8.4	<2	Moderate-----	0.37			
Zahill-----------	0-3	0.6-2.0	0.16-0.20	7.4-8.4	<2	Low----------	0.37	5	4L	.5-2
	3-60	0.2-0.6	0.14-0.18	7.4-8.4	<2	Moderate-----	0.32			
Bowbells---------	0-11	0.6-2.0	0.17-0.24	6.1-7.3	<2	Low----------	0.28	5	6	4-6
	11-27	0.6-2.0	0.16-0.22	6.1-7.3	<2	Moderate-----	0.28			
	27-60	0.2-0.6	0.14-0.18	7.9-8.4	<2	Moderate-----	0.37			
ZaE--------------- Zahill	0-3	0.6-2.0	0.16-0.20	7.4-8.4	<2	Low----------	0.37	5	4L	.5-2
	3-60	0.2-0.6	0.14-0.18	7.4-8.4	<2	Moderate-----	0.37			
ZcE--------------- Zahill	0-3	0.6-2.0	0.13-0.17	7.4-8.4	<2	Moderate-----	0.32	5	8	.5-2
	3-60	0.2-0.6	0.14-0.18	7.4-8.4	<2	Moderate-----	0.32			
ZlD*:										
Zahill-----------	0-3	0.6-2.0	0.16-0.20	7.4-8.4	<2	Low----------	0.37	5	4L	.5-2
	3-60	0.2-0.6	0.14-0.18	7.4-8.4	<2	Moderate-----	0.37			
La Prairie-------	0-15	0.6-2.0	0.17-0.22	6.6-8.4	<2	Low----------	0.28	5	6	2-6
	15-31	0.6-2.0	0.17-0.22	6.6-8.4	<2	Moderate-----	0.28			
	31-60	0.6-2.0	0.15-0.22	6.6-8.4	<2	Moderate-----	0.28			
ZmC*, ZmD*:										
Zahl-------------	0-6	0.6-2.0	0.17-0.22	6.6-7.8	<2	Moderate-----	0.28	5	4L	1-3
	6-60	0.06-0.6	0.15-0.19	7.4-8.4	<2	Moderate-----	0.37			
Max--------------	0-14	0.6-2.0	0.20-0.22	6.6-7.8	<2	Moderate-----	0.28	5	6	3-6
	14-60	0.2-0.6	0.14-0.19	7.9-8.4	<2	Moderate-----	0.37			

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--SOIL AND WATER FEATURES

["Flooding" and "water table" and terms such as "rare," "brief," "apparent," and "perched" are explained in the text. The symbol < means less than; > means more than. Absence of an entry indicates that the feature is not a concern]

Soil name and map symbol	Hydrologic group	Flooding			High water table			Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months		Uncoated steel	Concrete
					Ft					
Bb Bowbells	B	Occasional	Very brief	Mar-Nov	4.0-6.0	Perched	Apr-Jun	High	High	Low.
BoA Bowdle	B	None	---	---	>6.0	---	---	Low	Moderate	Low.
BrA*, BrB*:										
Bryant	B	None	---	---	>6.0	---	---	Moderate	High	Low.
Grassna	B	Occasional	Very brief	Mar-Nov	4.0-6.0	Perched	Apr-Jun	Moderate	High	Low.
Ha Harriet	D	Occasional	Long	Apr-Jun	0-1.0	Apparent	Sep-Jun	High	High	Moderate.
He Heil	D	None	---	---	+1-1.0	Apparent	Mar-Sep	Moderate	High	Moderate.
La La Prairie	B	Rare	---	---	3.5-6.0	Apparent	Mar-Jun	Moderate	Moderate	Low.
Lb La Prairie	B	Frequent	Brief	Mar-Jun	3.5-6.0	Apparent	Mar-Jun	Moderate	Moderate	Low.
LeA, LeB Lehr	B	None	---	---	>6.0	---	---	Low	Moderate	Low.
MaA Manning	B	None	---	---	>6.0	---	---	Low	Moderate	Low.
MbA Manning Variant	B	None	---	---	2.0-4.0	Apparent	Sep-Jun	High	High	Low.
MdA*:										
Max	B	None	---	---	>6.0	---	---	Moderate	High	Low.
Arnegard	B	Occasional	Very brief	Mar-Oct	3.0-6.0	Perched	Mar-Oct	Moderate	High	Low.
MmB*:										
Max	B	None	---	---	>6.0	---	---	Moderate	High	Low.
Arnegard	B	Occasional	Very brief	Mar-Oct	3.0-6.0	Perched	Mar-Oct	Moderate	High	Low.
Zahl	B	None	---	---	>6.0	---	---	Moderate	Moderate	Low.
MnB*:										
Max	B	None	---	---	>6.0	---	---	Moderate	High	Low.
Niobell	C	None	---	---	>6.0	---	---	Moderate	High	Moderate.
Noonan	D	None	---	---	>6.0	---	---	Moderate	High	Moderate.
MoA, MoB Mondamin	C	None	---	---	5.0-6.0	Perched	Oct-Jun	Low	High	Low.
NaA*:										
Niobell	C	None	---	---	>6.0	---	---	Moderate	High	Moderate.
Noonan	D	None	---	---	>6.0	---	---	Moderate	High	Moderate.
NbA*:										
Niobell	C	None	---	---	>6.0	---	---	Moderate	High	Moderate.
Noonan	D	None	---	---	>6.0	---	---	Moderate	High	Moderate.

See footnote at end of table.

TABLE 15.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months		Uncoated steel	Concrete
					Ft					
NbA*:										
Max	B	None	---	---	>6.0	---	---	Moderate	High	Low.
Nn Nishon	D	None	---	---	+.5-1.0	Perched	Apr-Aug	Moderate	High	Low.
NoA*:										
Noonan	D	None	---	---	>6.0	---	---	Moderate	High	Moderate.
Miranda	D	None	---	---	>6.0	---	---	Moderate	High	Moderate.
Pa, Pp Parnell	C/D	None	---	---	+2-2.0	Apparent	Jan-Dec	High	High	Low.
Pt*. Pits										
RaA*, RaB*:										
Raber	C	None	---	---	>6.0	---	---	Low	High	Moderate.
Cavo	D	None	---	---	>6.0	---	---	Low	High	Moderate.
Rh*:										
Ranslo	D	Occasional	Very brief	Apr-Oct	1.0-3.0	Apparent	Apr-Jun	High	High	Moderate.
Harriet	D	Occasional	Long	Apr-Jun	0-1.0	Apparent	Sep-Jun	High	High	Moderate.
TaA, TaB Tally	B	None	---	---	>6.0	---	---	Moderate	High	Low.
Tn*:										
Tonka	C/D	None	---	---	+.5-1.0	Apparent	Apr-Jun	High	High	Low.
Nishon	D	None	---	---	+.5-1.0	Perched	Apr-Aug	Moderate	High	Low.
VaC*:										
Vida	B	None	---	---	>6.0	---	---	Moderate	High	Low.
Williams	B	None	---	---	>6.0	---	---	Moderate	High	Low.
VdC*:										
Vida	C	None	---	---	>6.0	---	---	Moderate	High	Low.
Williams	B	None	---	---	>6.0	---	---	Moderate	High	Low.
Bowbells	B	Occasional	Very brief	Mar-Nov	4.0-6.0	Perched	Apr-Jun	High	High	Low.
WaD Wabek	A	None	---	---	>6.0	---	---	Low	Moderate	Low.
WbC*:										
Wabek	A	None	---	---	>6.0	---	---	Low	Moderate	Low.
Bowdle	B	None	---	---	>6.0	---	---	Low	Moderate	Low.
WnA*, WnB*:										
Williams	B	None	---	---	>6.0	---	---	Moderate	High	Low.
Bowbells	B	Occasional	Very brief	Mar-Nov	4.0-6.0	Perched	Apr-Jun	High	High	Low.
WoA*, WoB*:										
Williams	B	None	---	---	>6.0	---	---	Moderate	High	Low.
Bowbells	B	Occasional	Very brief	Mar-Nov	4.0-6.0	Perched	Apr-Jun	High	High	Low.

See footnote at end of table.

TABLE 15.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months		Uncoated steel	Concrete
					Ft					
WoA*, WoB*:										
Nishon-----------	D	None--------	---	---	+.5-1.0	Perched	Apr-Aug	Moderate	High-----	Low.
WpA*, WpB*:										
Williams---------	B	None--------	---	---	>6.0	---	---	Moderate	High-----	Low.
Bowbells---------	B	Occasional	Very brief	Mar-Nov	4.0-6.0	Perched	Apr-Jun	High-----	High-----	Low.
Noonan-----------	D	None--------	---	---	>6.0	---	---	Moderate	High-----	Moderate.
WtC*:										
Williams---------	B	None--------	---	---	>6.0	---	---	Moderate	High-----	Low.
Bowbells---------	B	Occasional	Very brief	Mar-Nov	4.0-6.0	Perched	Apr-Jun	High-----	High-----	Low.
Parnell----------	C/D	None--------	---	---	+2-2.0	Apparent	Jan-Dec	High-----	High-----	Low.
WvB*:										
Williams---------	B	None--------	---	---	>6.0	---	---	Moderate	High-----	Low.
Bowbells---------	B	Occasional	Very brief	Mar-Nov	4.0-6.0	Perched	Apr-Jun	High-----	High-----	Low.
Vida-------------	C	None--------	---	---	>6.0	---	---	Moderate	High-----	Low.
WwB*:										
Williams---------	B	None--------	---	---	>6.0	---	---	Moderate	High-----	Low.
Niobell----------	C	None--------	---	---	>6.0	---	---	Moderate	High-----	Moderate.
Noonan-----------	D	None--------	---	---	>6.0	---	---	Moderate	High-----	Moderate.
WxC*:										
Williams---------	B	None--------	---	---	>6.0	---	---	Moderate	High-----	Low.
Vida-------------	B	None--------	---	---	>6.0	---	---	Moderate	High-----	Low.
Bowbells---------	B	Occasional	Very brief	Mar-Nov	4.0-6.0	Perched	Apr-Jun	High-----	High-----	Low.
WzD*:										
Williams---------	B	None--------	---	---	>6.0	---	---	Moderate	High-----	Low.
Zahill-----------	B	None--------	---	---	>6.0	---	---	Moderate	High-----	Low.
Bowbells---------	B	Occasional	Very brief	Mar-Nov	4.0-6.0	Perched	Apr-Jun	High-----	High-----	Low.
ZaE, ZcE---------- Zahill	B	None--------	---	---	>6.0	---	---	Moderate	High-----	Low.
ZlD*:										
Zahill-----------	B	None--------	---	---	>6.0	---	---	Moderate	High-----	Low.
La Prairie-------	B	Frequent----	Brief-----	Mar-Jun	3.5-6.0	Apparent	Mar-Jun	Moderate	Moderate	Low.
ZmC*, ZmD*:										
Zahl-------------	B	None--------	---	---	>6.0	---	---	Moderate	Moderate	Low.
Max--------------	B	None--------	---	---	>6.0	---	---	Moderate	High-----	Low.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 16.--ENGINEERING INDEX TEST DATA

[Dashes indicate that data were not available. NP means nonplastic]

Soil name, report number, horizon, and depth in inches	Classification		Grain-size distribution								Liquid limit	Plasticity index	Moisture density	
			Percentage passing sieve--					Percentage smaller than--						
	AASHTO	Unified	3/8 inch	No. 4	No. 10	No. 40	No. 200	.02 mm	.005 mm	.002 mm			Max. dry density	Optimum moisture
											Pct		Lb/ft^3	Pct
Harriet silt loam: (S78SD-049-26)														
Bt----- 3 to 11	A-7-6(20)	CH	100	100	100	99	93	--	48	--	59	36	92	26
Cz----- 11 to 24	A-7-6(20)	CH	100	100	100	99	95	--	54	--	60	38	96	24
Cky---- 24 to 42	A-6(12)	CL	100	100	100	99	95	--	38	--	37	19	112	16
La Prairie loam: (S78SD-049-15)														
A------ 0 to 15	A-6(8)	CL	100	100	100	99	70	--	22	--	33	11	102	20
C------ 23 to 60	A-4(5)	CL	100	100	99	97	62	--	20	--	29	9	112	16
Miranda loam: (S78SD-049-22)														
Bt----- 5 to 13	A-6(6)	CL	100	99	97	86	54	--	23	--	32	15	112	16
BCz---- 13 to 20	A-7-6(11)	CL	100	99	98	92	66	--	33	--	41	23	110	17
Mondamin silty clay loam: (S78SD-049-17)														
Ap---- 0 to 6	A-7-6(13)	CL	100	100	100	99	91	--	46	--	49	23	92	26
Bt---- 6 to 14	A-7-6(19)	CH	100	100	100	99	95	--	52	--	55	32	96	24
C----- 27 to 60	A-7-6(20)	CH	100	100	100	100	96	--	60	--	63	38	97	23
Niobell loam: (S78SD-049-29)														
Bt----- 10 to 24	A-6(10)	CL	100	96	95	90	66	--	32	--	37	19	108	18
C------ 29 to 60	A-6(10)	CL	100	99	97	90	63	--	29	--	35	19	115	15
Nishon silt loam: (S78SD-049-11)														
Bt----- 6 to 29	A-7-6(20)	CH	100	100	100	99	95	--	62	--	64	39	95	24
C------ 41 to 60	A-7-6(19)	CH	100	100	100	99	95	--	54	--	54	31	97	23
Noonan loam: (S78SD-049-23)														
Bt----- 8 to 19	A-7-6(13)	CL	100	100	100	95	77	--	35	--	41	22	105	19
Cky---- 23 to 34	A-6(10)	CL	100	99	97	89	65	--	33	--	37	20	113	15
C------ 34 to 60	A-6(10)	CL	100	98	97	91	64	--	27	--	37	20	112	16
Ranslo silt loam: (S78SD-049-28)														
Bt----- 8 to 24	A-7-6(19)	CH	100	100	100	99	90	--	42	--	53	32	95	24
C------ 30 to 60	A-6(9)	CL	100	100	100	100	88	--	32	--	36	13	111	16

TABLE 16.--ENGINEERING TEST INDEX DATA--Continued

Soil name, report number, horizon, and depth in inches	Classification		Grain-size distribution								Liquid limit	Plasticity index	Moisture density	
			Percentage passing sieve--					Percentage smaller than--						
	AASHTO	Unified	3/8 inch	No. 4	No. 10	No. 40	No. 200	.02 mm	.005 mm	.002 mm			Max. dry density	Optimum moisture
											Pct		Lb/ ft^3	Pct
Tally fine sandy loam: (S78SD-049-14)														
Ap---- 0 to 8	A-4(0)	SC	100	100	100	85	36	--	16	--	26	8	115	15
Bw---- 8 to 24	A-2-4(0)	SC	100	100	100	88	32	--	16	--	23	8	122	12
C----- 30 to 60	A-2-4(0)	SM	100	100	99	84	22	--	12	--	22	NP	118	13
Vida loam: (S77SD-049-44)														
BCk---- 9 to 18	A-7-6(15)	CL	100	98	97	92	73	--	41	--	43	24	105	19
C------ 18 to 60	A-7-6(13)	CL	100	94	93	87	63	--	37	--	44	24	107	18
Williams loam: (S78SD-049-3)														
Ap----- 0 to 7	A-6(9)	ML	100	100	99	96	79	--	30	--	42	13	91	26
Bt----- 7 to 18	A-7-6(12)	CL	100	100	99	93	68	--	35	--	44	23	105	19
C------ 30 to 60	A-7-6(11)	CL	100	98	96	88	64	--	30	--	42	22	110	17
Zahill loam: (S78SD-049-13)														
C1----- 21 to 45	A-7-6(11)	CL	100	94	92	82	64	--	31	--	45	23	102	20

TABLE 17.--CLASSIFICATION OF THE SOILS

[An asterisk in the first column indicates that the soil is a taxadjunct to the series. See text for a description of those characteristics of the soil that are outside the range of the series]

Soil name	Family or higher taxonomic class
*Arnegard	Fine-loamy, mixed Pachic Haploborolls
*Bowbells	Fine-loamy, mixed Pachic Argiborolls
*Bowdle	Fine-loamy over sandy or sandy-skeletal, mixed Pachic Haploborolls
Bryant	Fine-silty, mixed Typic Haploborolls
Cavo	Fine, montmorillonitic, mesic Typic Natrustolls
*Grassna	Fine-silty, mixed Pachic Haploborolls
Harriet	Fine, mixed, frigid Typic Natraquolls
Heil	Fine, montmorillonitic, frigid Typic Natraquolls
La Prairie	Fine-loamy, mixed Cumulic Udic Haploborolls
Lehr	Fine-loamy over sandy or sandy-skeletal, mixed Typic Haploborolls
Manning	Coarse-loamy over sandy or sandy-skeletal, mixed Typic Haploborolls
Manning Variant	Sandy over loamy, mixed, mesic Aquic Haploborolls
Max	Fine-loamy, mixed Typic Haploborolls
Miranda	Fine-loamy, mixed Leptic Natriborolls
Mondamin	Fine, montmorillonitic Typic Argiborolls
Niobell	Fine-loamy, mixed Glossic Natriborolls
Nishon	Fine, montmorillonitic, frigid Typic Albaqualfs
Noonan	Fine-loamy, mixed Typic Natriborolls
Parnell	Fine, montmorillonitic, frigid Typic Argiaquolls
Raber	Fine, montmorillonitic, mesic Typic Argiustolls
Ranslo	Fine, montmorillonitic, frigid Typic Natraquolls
Tally	Coarse-loamy, mixed Typic Haploborolls
Tonka	Fine, montmorillonitic, frigid Argiaquic Argialbolls
Vida	Fine-loamy, mixed Typic Argiborolls
Wabek	Sandy-skeletal, mixed Entic Haploborolls
Williams	Fine-loamy, mixed Typic Argiborolls
Zahill	Fine-loamy, mixed (calcareous), frigid Typic Ustorthents
Zahl	Fine-loamy, mixed Entic Haploborolls

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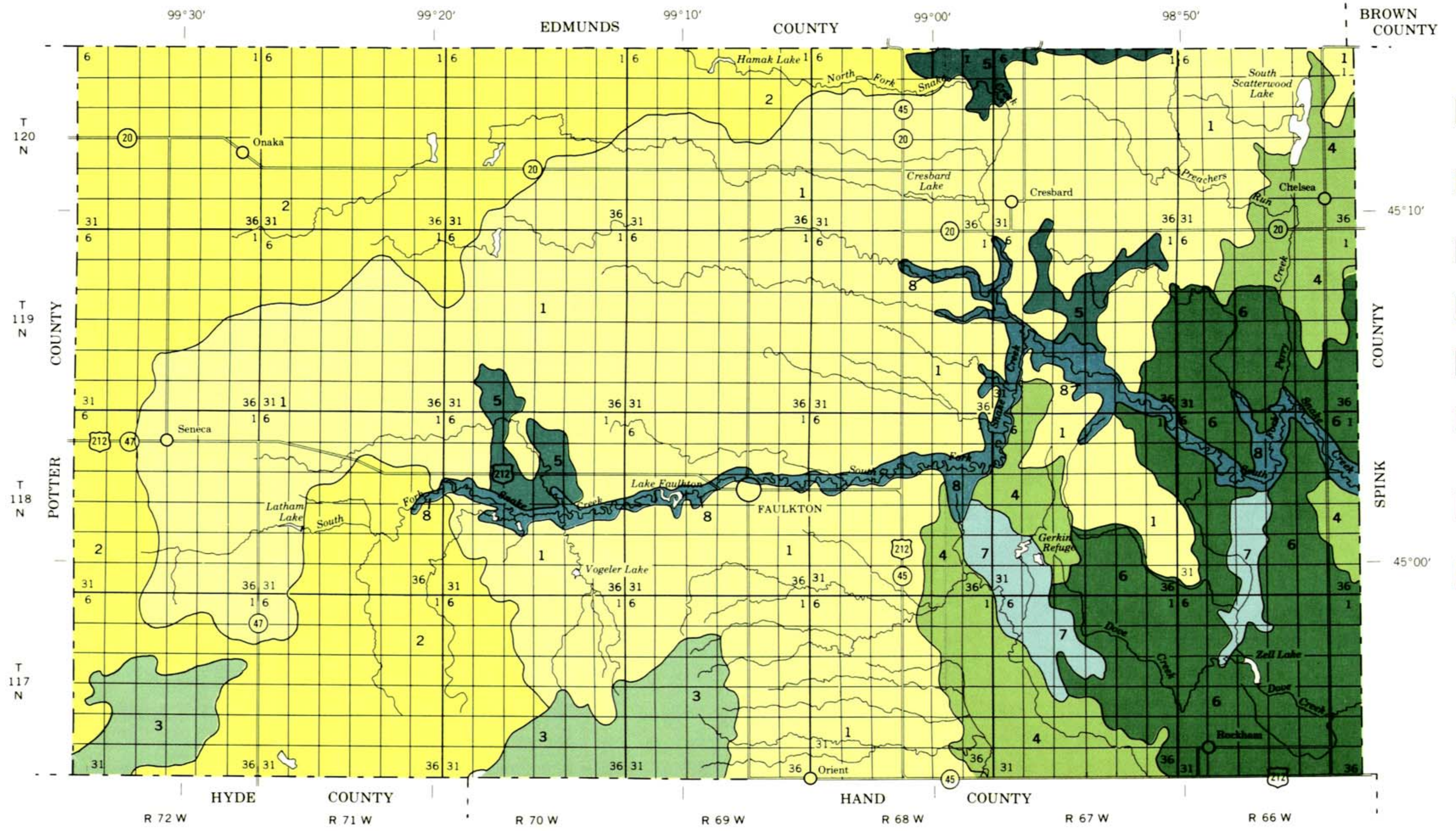

LEGEND *

1	Williams-Bowbells association: Well drained and moderately well drained, nearly level and undulating, loamy soils on uplands and in upland swales
2	Williams-Bowbells-Vida association: Well drained and moderately well drained, nearly level to moderately sloping, loamy soils on uplands and in upland swales
3	Williams-Zahill-Bowbells association: Well drained and moderately well drained, nearly level to steep, loamy soils on uplands and in upland swales
4	Max-Arnegard-Zahl association: Well drained, nearly level to moderately steep, loamy soils on uplands and in upland swales
5	Bryant-Grassna association: Well drained and moderately well drained, nearly level and gently sloping, silty soils on uplands and in upland swales
6	Max-Niobell-Noonan association: Well drained, gently sloping and moderately sloping, loamy soils and moderately well drained, nearly level and gently sloping, sodium affected, loamy soils; on uplands
7	Noonan-Miranda association: Moderately well drained and somewhat poorly drained, nearly level and undulating, sodium affected, loamy soils on uplands
8	La Prairie-Zahill-Lehr association: Moderately well drained to somewhat excessively drained, nearly level to steep, loamy soils on flood plains, terraces, and uplands

*The texture terms in the descriptive headings refer to the surface layer of the major soils in each association.

Compiled 1982

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

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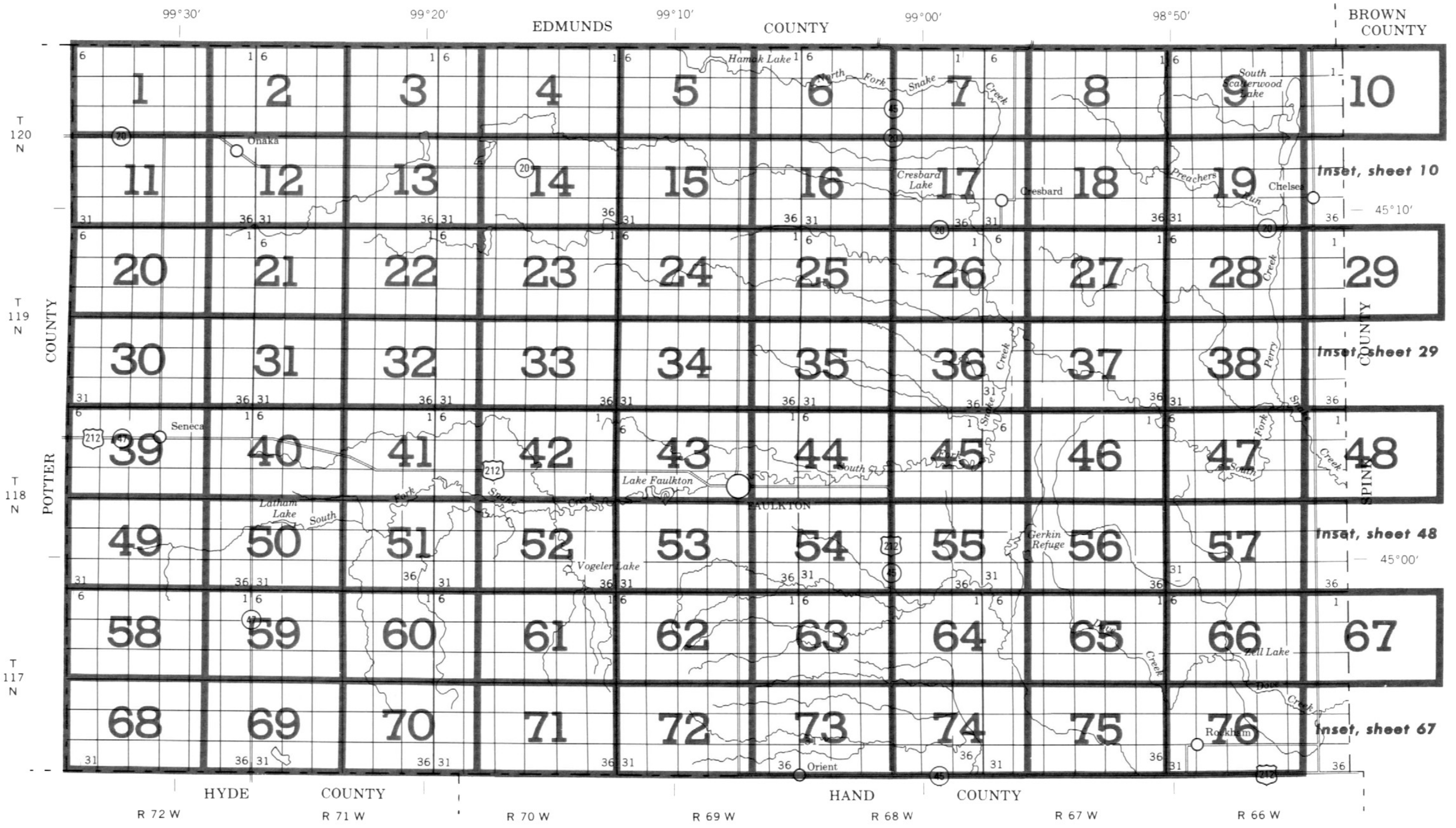
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
SOUTH DAKOTA AGRICULTURAL EXPERIMENT STATION

GENERAL SOIL MAP

FAULK COUNTY, SOUTH DAKOTA

1 0 1 2 3 4 Miles

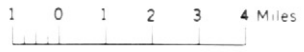


SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

Original text from each individual map sheet read:
This map is compiled on 1976 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

INDEX TO MAP SHEETS
FAULK COUNTY, SOUTH DAKOTA



SOIL LEGEND

Map symbols consist of a combination of letters. The first capital letter is the initial one of the map unit name. The lowercase letter that follows separates map units having names that begin with the same letter, except that it does not separate sloping phases. The second capital letter indicates the class of slope. Symbols without a slope letter are for nearly level soils or miscellaneous areas.

SYMBOL	NAME
Bb	Bowbells loam
BoA	Bowdle loam, 0 to 3 percent slopes
BrA	Bryant-Grassna silt loams, 0 to 2 percent slopes
BrB	Bryant-Grassna silt loams, 2 to 6 percent slopes
Ha	Harriet silt loam
He	Heil silt loam
La	La Prairie loam
Lb	La Prairie loam, channeled
LeA	Lehr loam, 0 to 3 percent slopes
LeB	Lehr loam, 3 to 6 percent slopes
MaA	Manning sandy loam, 0 to 3 percent slopes
MbA	Manning Variant loam, 0 to 3 percent slopes
MdA	Max-Arnegard loams, 0 to 3 percent slopes
MmB	Max-Arnegard-Zahl loams, 1 to 6 percent slopes
MnB	Max-Niobell-Noonan loams, 2 to 6 percent slopes
MoA	Mondamin silty clay loam, 0 to 2 percent slopes
MoB	Mondamin silty clay loam, 2 to 6 percent slopes
NaA	Niobell-Noonan loams, 0 to 3 percent slopes
NbA	Niobell-Noonan-Max loams, 0 to 3 percent slopes
Nn	Nishon silt loam
NoA	Noonan-Miranda loams, 0 to 5 percent slopes
Pa	Parnell silty clay loam
Pp	Parnell silty clay loam, ponded
Pt	Pits, gravel
RaA	Raber-Cavo complex, 0 to 2 percent slopes
RaB	Raber-Cavo complex, 2 to 6 percent slopes
Rh	Ranslo-Harriet silt loams
TaA	Tally fine sandy loam, 0 to 2 percent slopes
TaB	Tally fine sandy loam, 2 to 6 percent slopes
Tn	Tonka-Nishon silt loams
Vac	Vida-Williams very stony loams, 2 to 9 percent slopes
VdC	Vida-Williams-Bowbells loams, 2 to 9 percent slopes
WaD	Wabek loam, 9 to 25 percent slopes
WbC	Wabek-Bowdle loams, 3 to 9 percent slopes
WnA	Williams-Bowbells loams, 0 to 3 percent slopes
WnB	Williams-Bowbells loams, 1 to 6 percent slopes
WoA	Williams-Bowbells-Nishon complex, 0 to 3 percent slopes
WoB	Williams-Bowbells-Nishon complex, 1 to 6 percent slopes
WpA	Williams-Bowbells-Noonan loams, 0 to 3 percent slopes
WpB	Williams-Bowbells-Noonan loams, 1 to 6 percent slopes
WtC	Williams-Bowbells-Parnell complex, 1 to 9 percent slopes
WvB	Williams-Bowbells-Vida loams, 1 to 6 percent slopes
WwB	Williams-Niobell-Noonan loams, 3 to 6 percent slopes
WxC	Williams-Vida-Bowbells complex, 2 to 9 percent slopes
WzD	Williams-Zahill-Bowbells loams, 2 to 15 percent slopes
ZaE	Zahill loam, 15 to 40 percent slopes
ZcE	Zahill very stony loam, 6 to 25 percent slopes
ZlD	Zahill-La Prairie complex, 2 to 25 percent slopes
ZmC	Zahl-Max loams, 6 to 9 percent slopes
ZmD	Zahl-Max loams, 9 to 20 percent slopes

CONVENTIONAL AND SPECIAL SYMBOLS LEGEND

CULTURAL FEATURES

BOUNDARIES	
County or parish	——— –
Field sheet matchline & neatline	———
AD HOC BOUNDARY (label)	Davis Airstrip ┼
Small airport, airfield, park, oilfield, cemetery, or flood pool	FLOOD POOL LINE
STATE COORDINATE TICK	——┴——
LAND DIVISION CORNERS (sections and land grants)	└ ┴ ┼ ┬┴
ROADS	
Other roads	———
ROAD EMBLEMS & DESIGNATIONS	
Federal	410
State	52
County, farm or ranch	378
DAMS	
Medium or small	water w
PITS	
Gravel pit	✕
MISCELLANEOUS CULTURAL FEATURES	
Farmstead, house (omit in urban areas)	•
Church	⍿
School	⍿

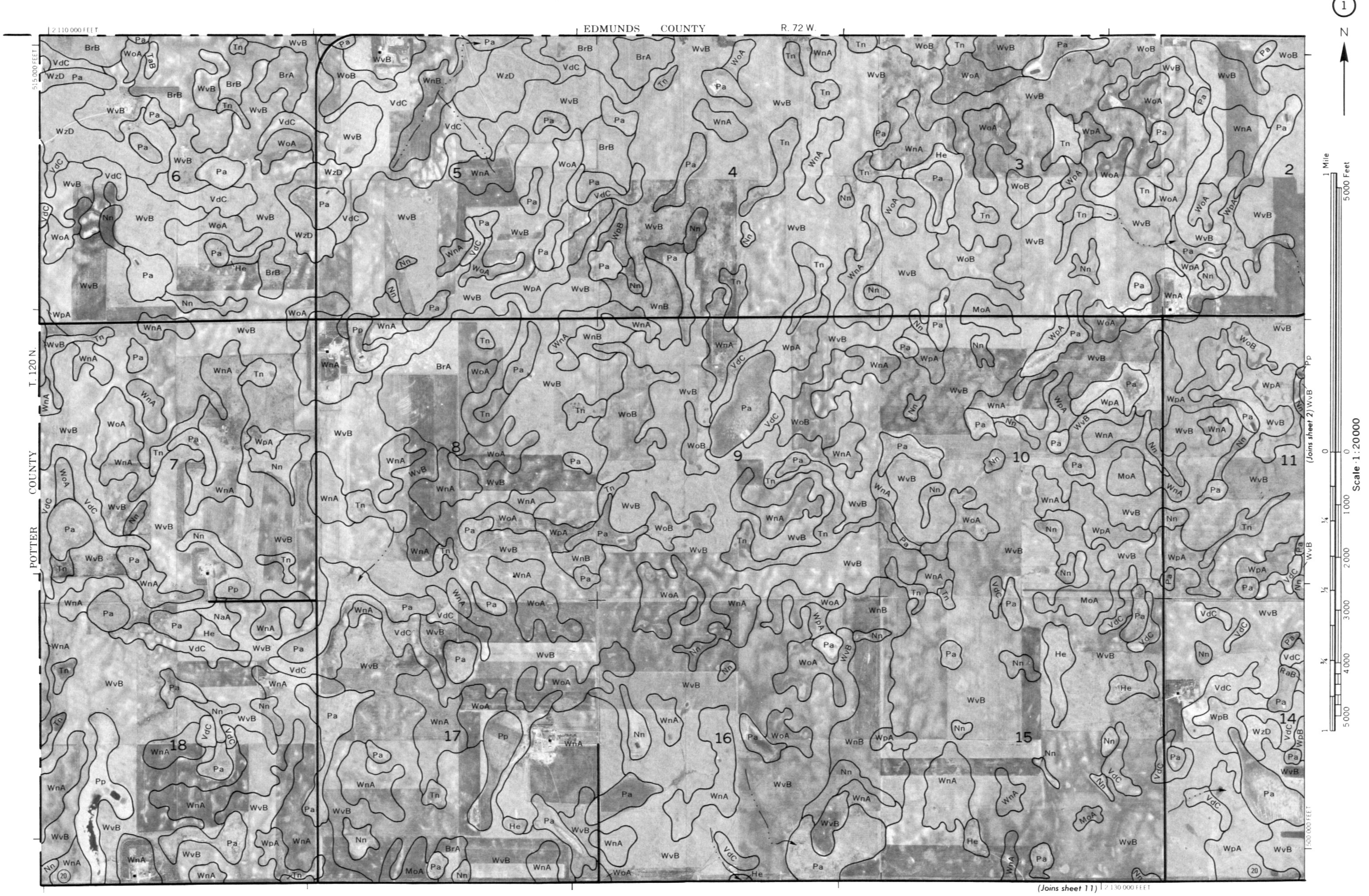
WATER FEATURES

DRAINAGE	
Perennial, single line	～
Intermittent	- ～ -
Drainage end	～→
Canals or ditches	
Drainage and/or irrigation	—►—►
LAKES, PONDS AND RESERVOIRS	
Perennial	water
MISCELLANEOUS WATER FEATURES	
Wet spot	ψ

SPECIAL SYMBOLS FOR SOIL SURVEY

SOIL DELINEATIONS AND SYMBOLS	Bb Wad
MISCELLANEOUS	
Gravelly spot	°°
Sandy spot	∴
Stony spot, very stony spot	o ꝏ

FAULK COUNTY, SOUTH DAKOTA — SHEET NUMBER 1



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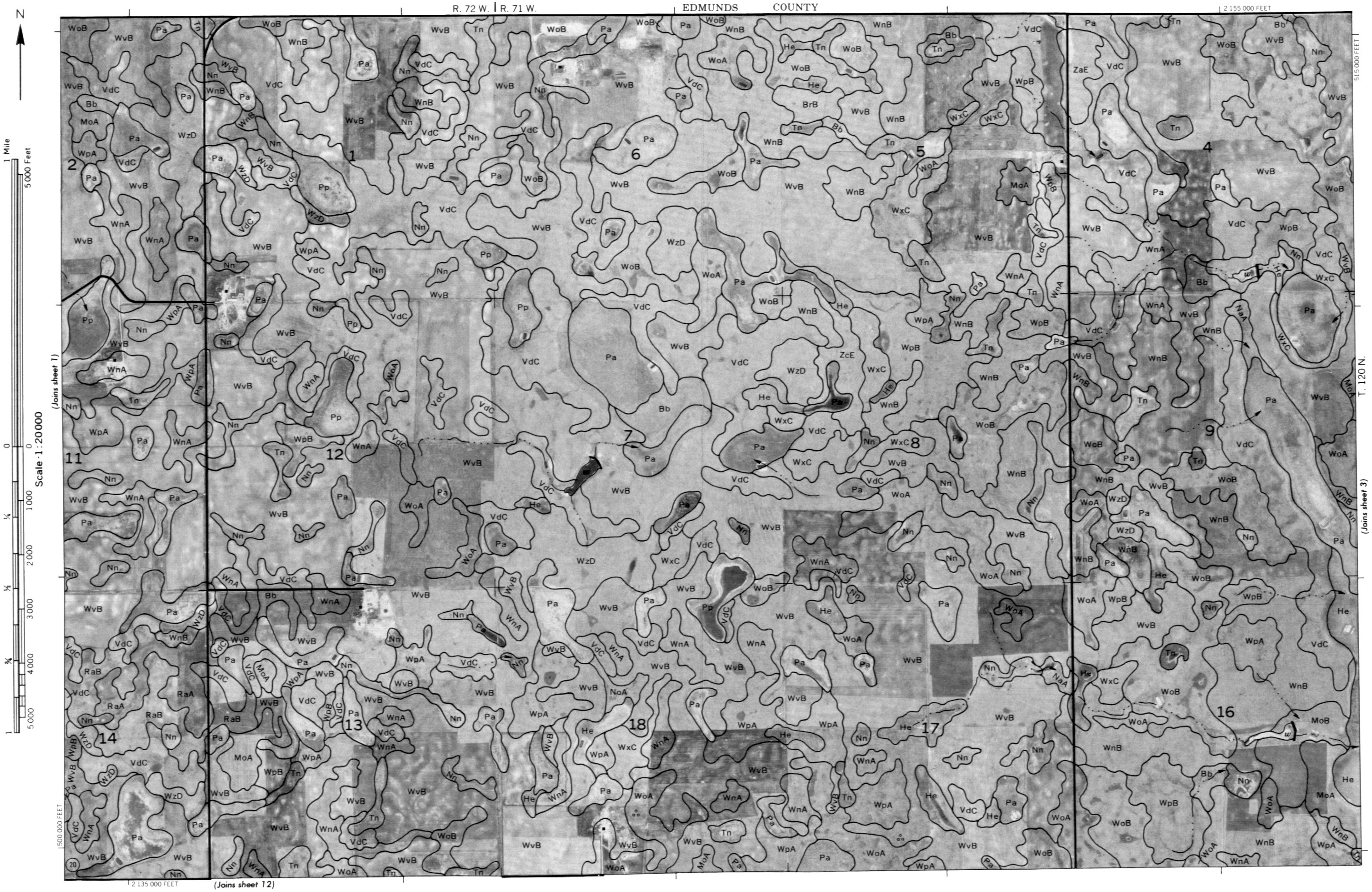

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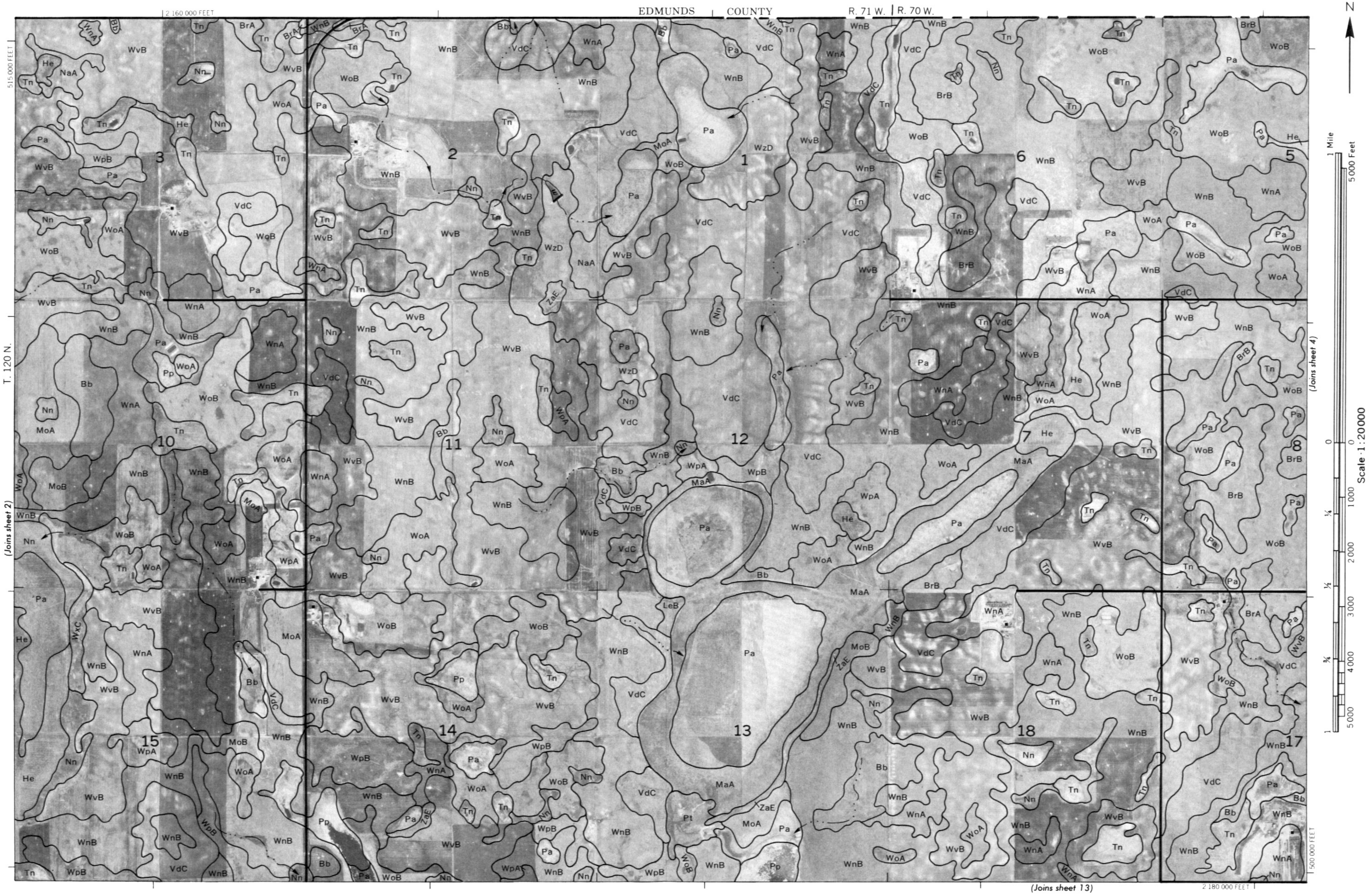

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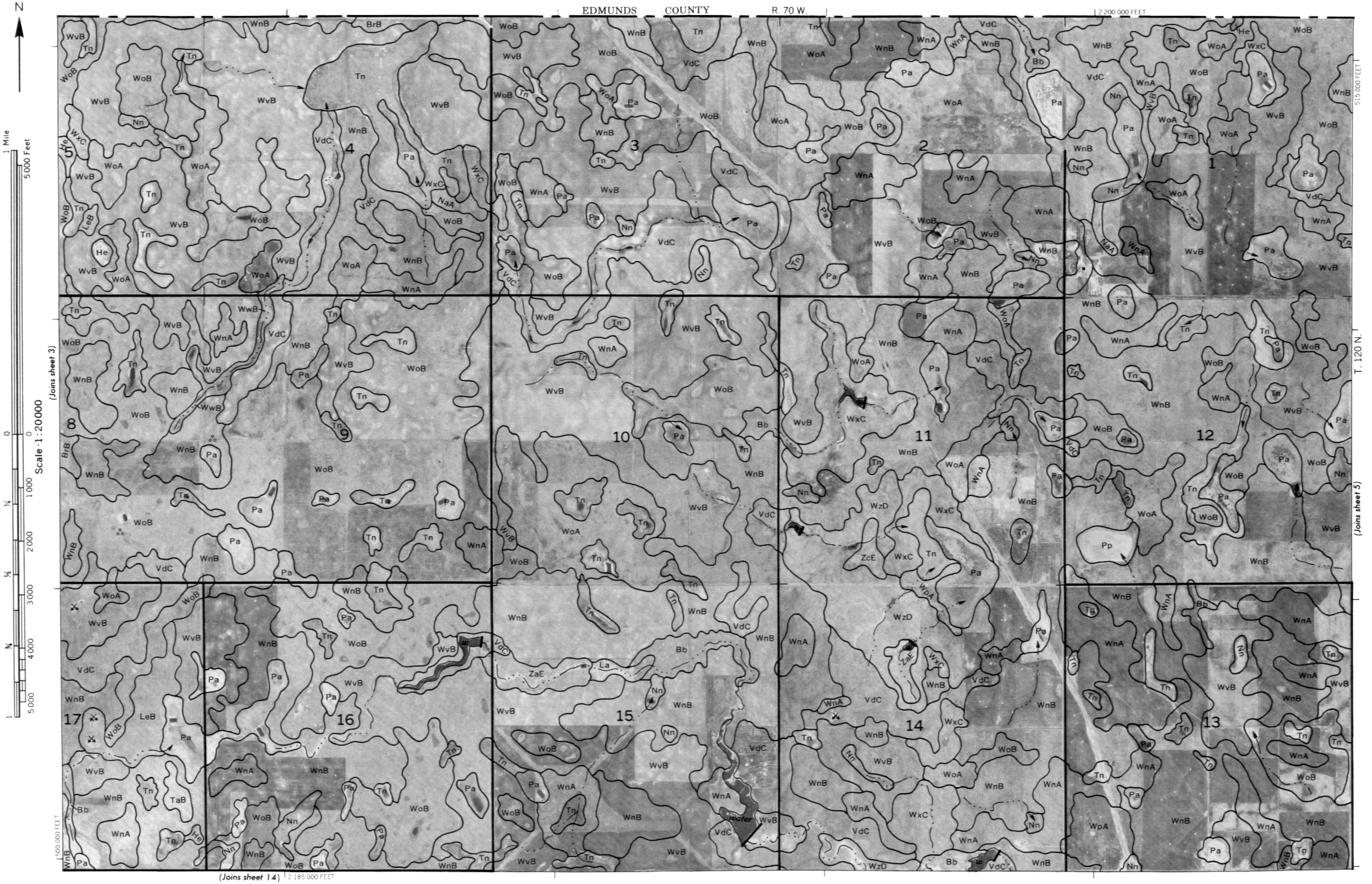

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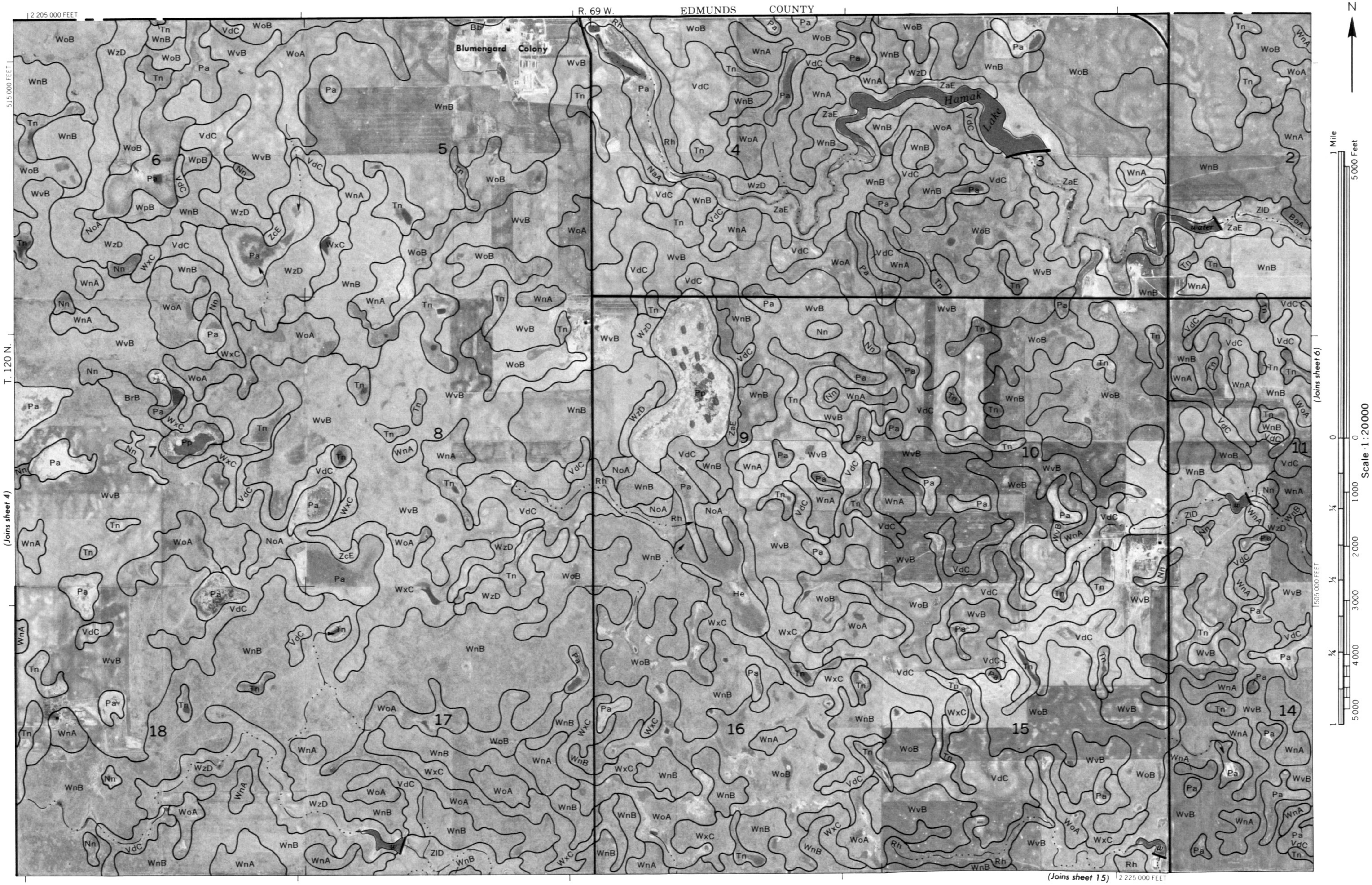

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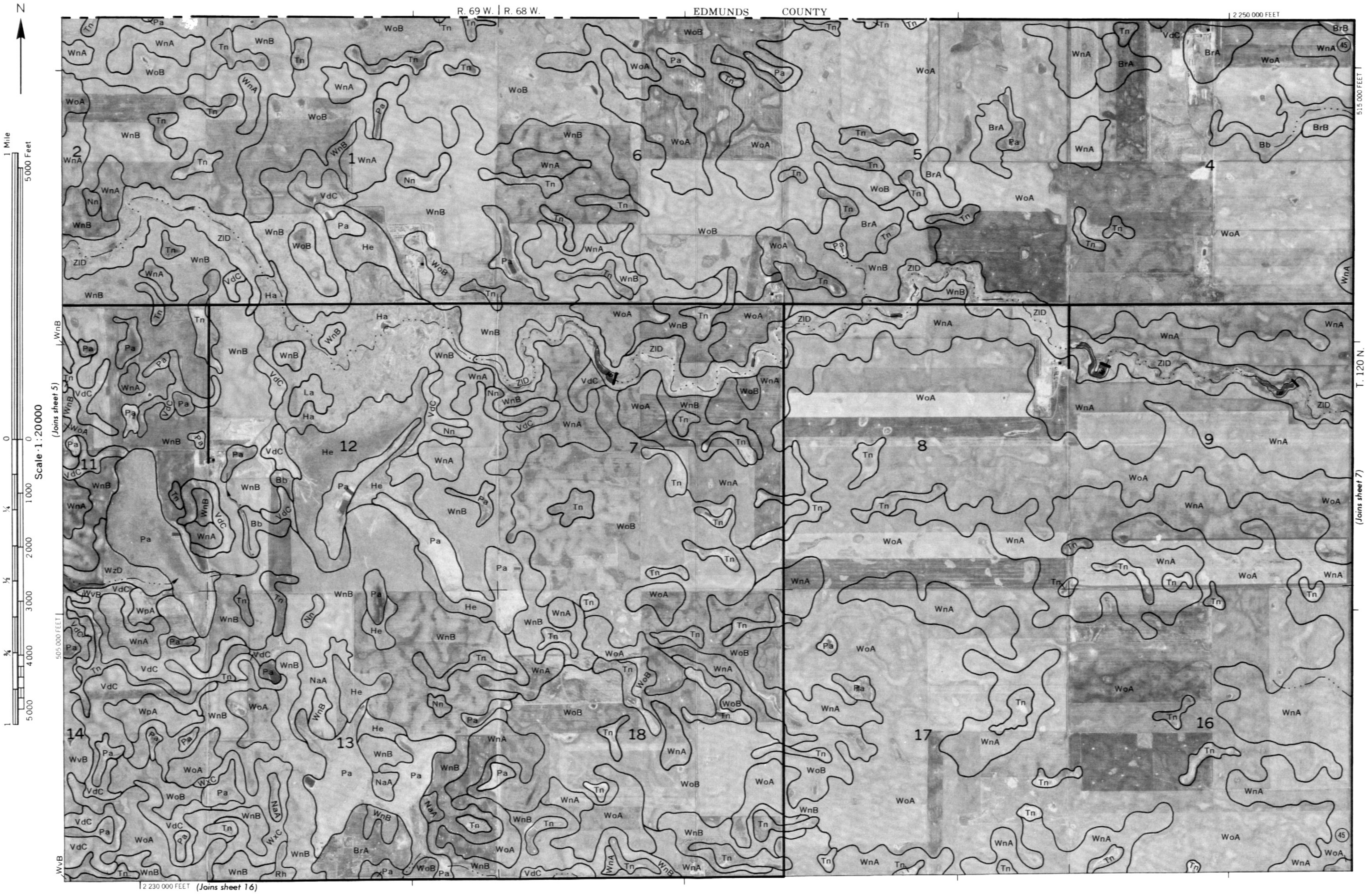

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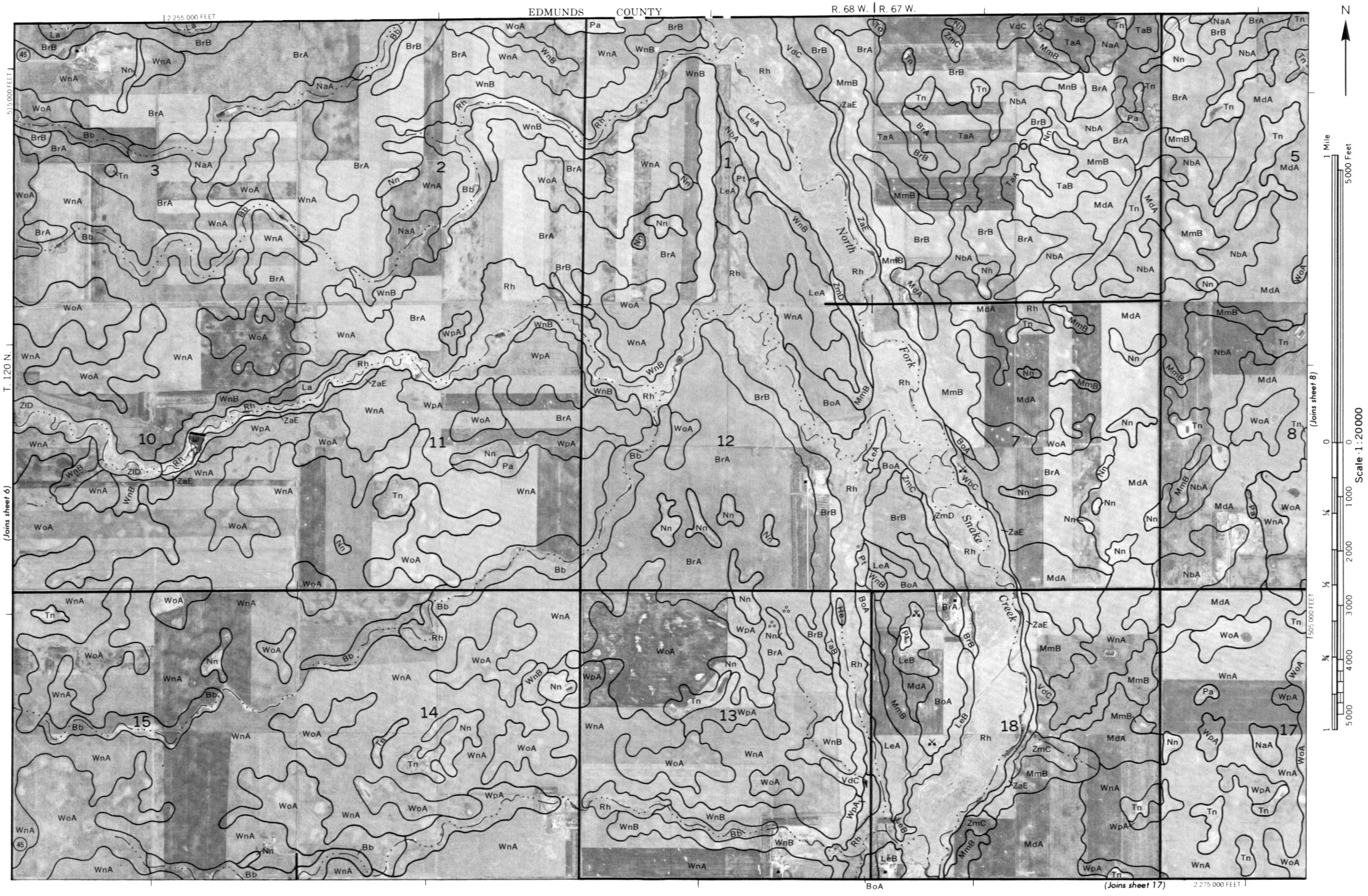

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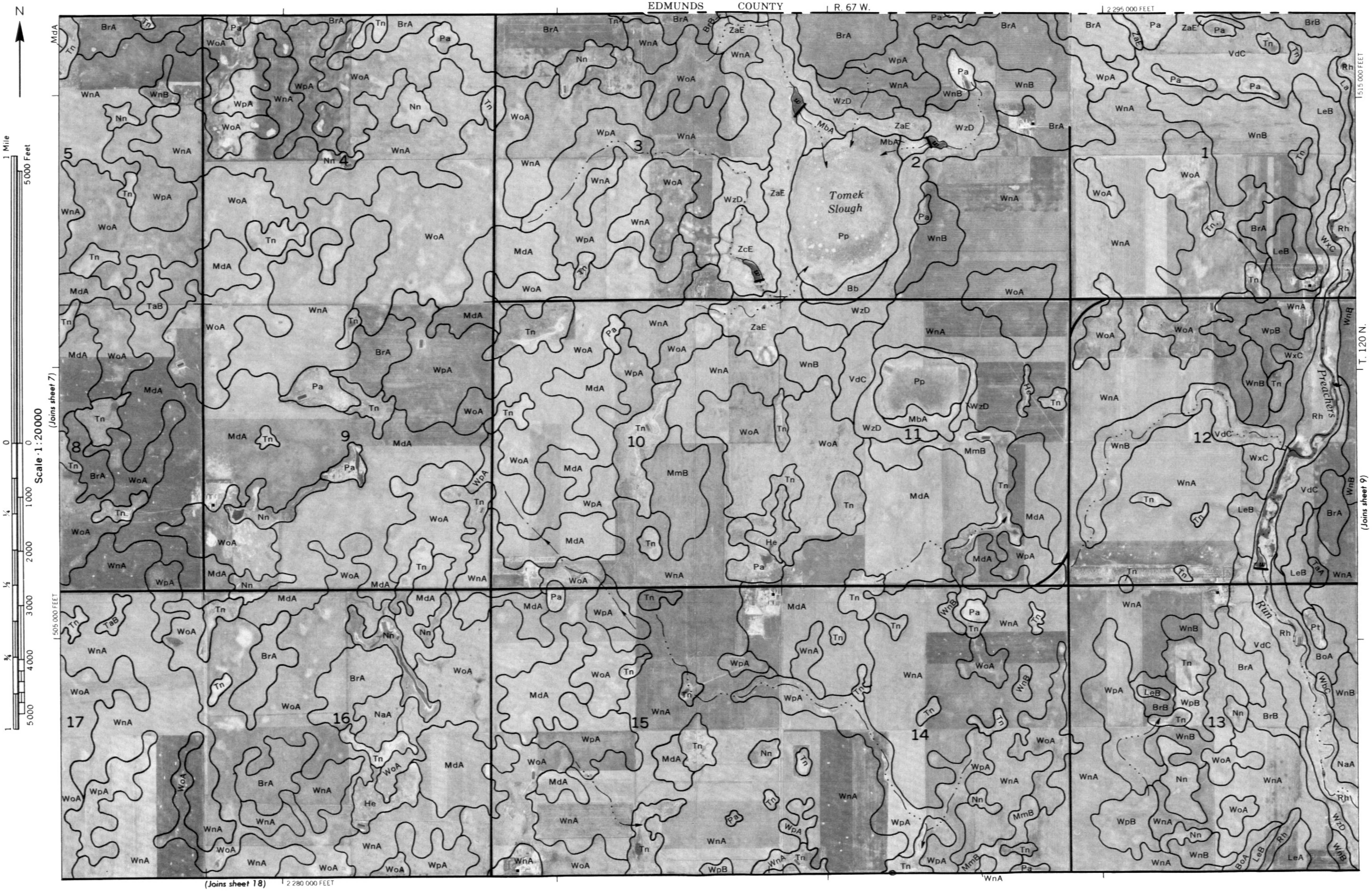

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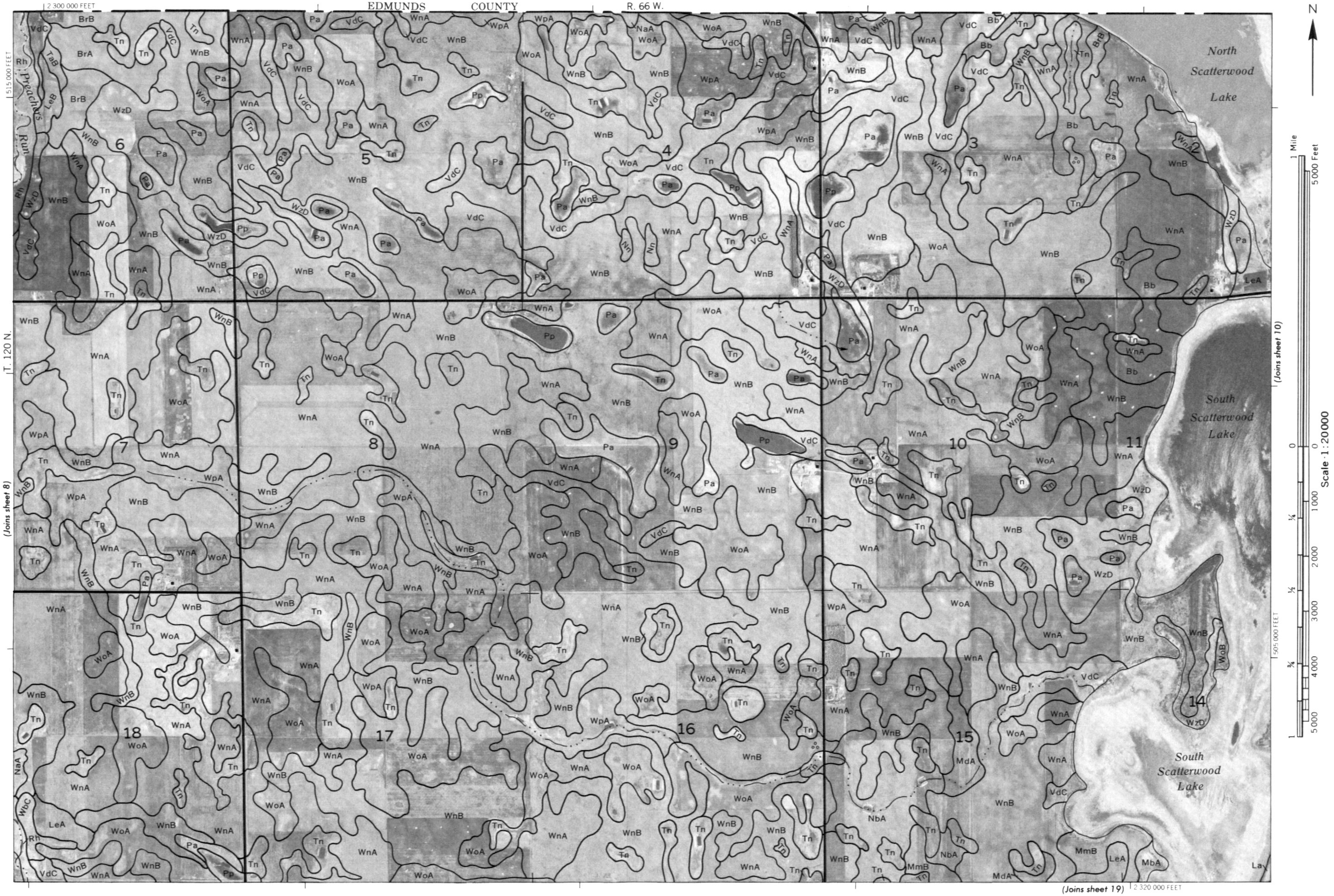

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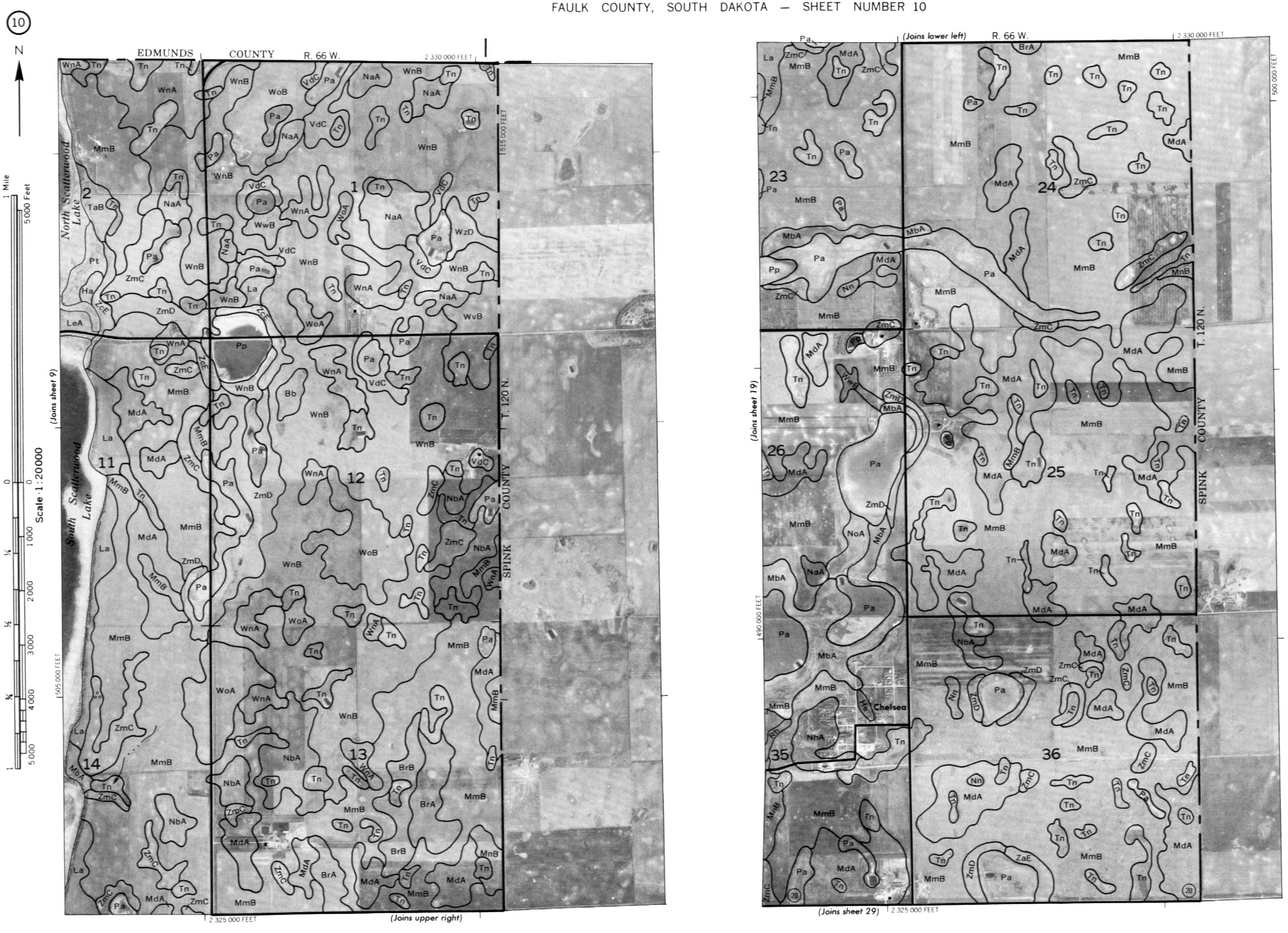

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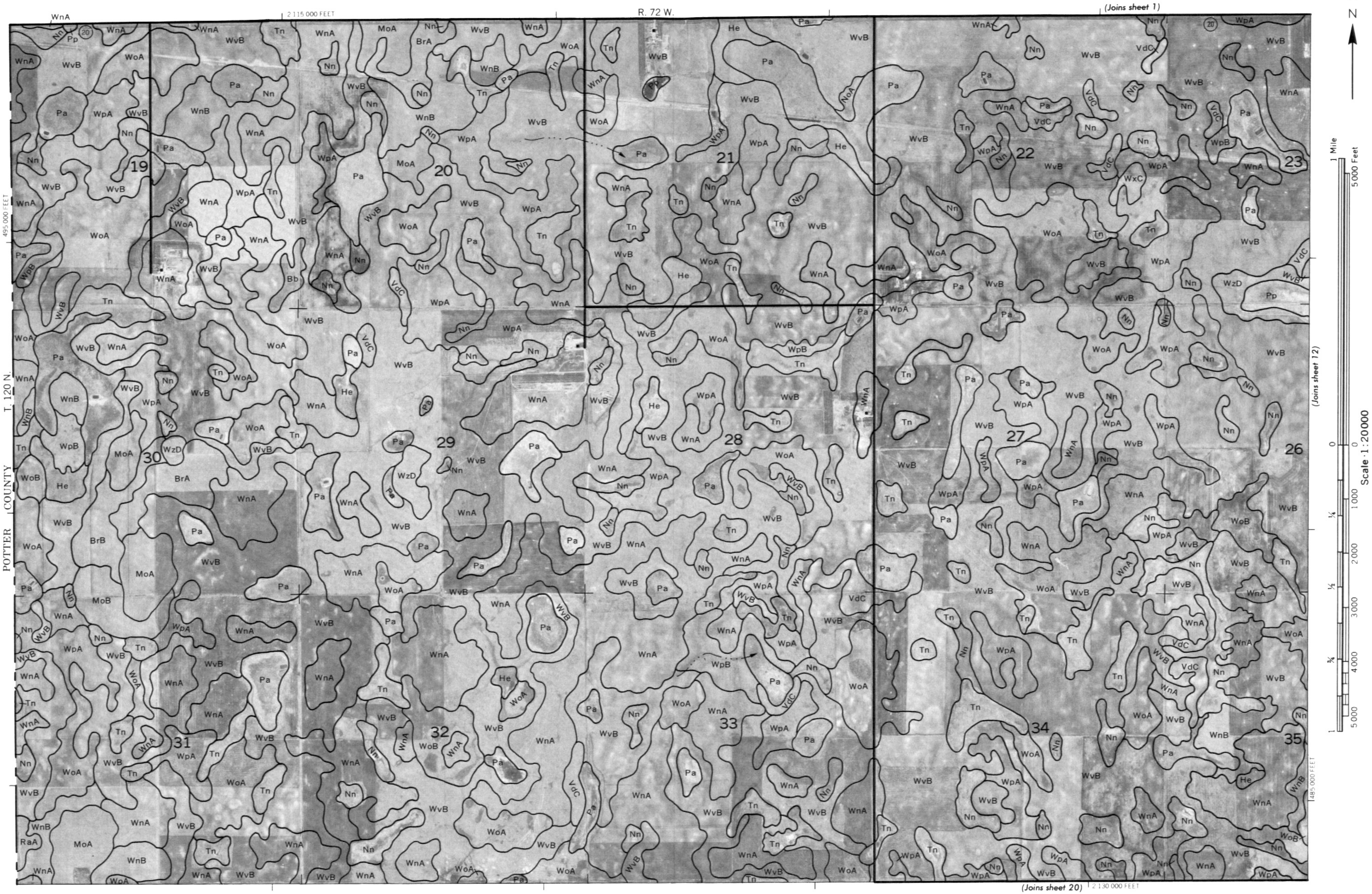

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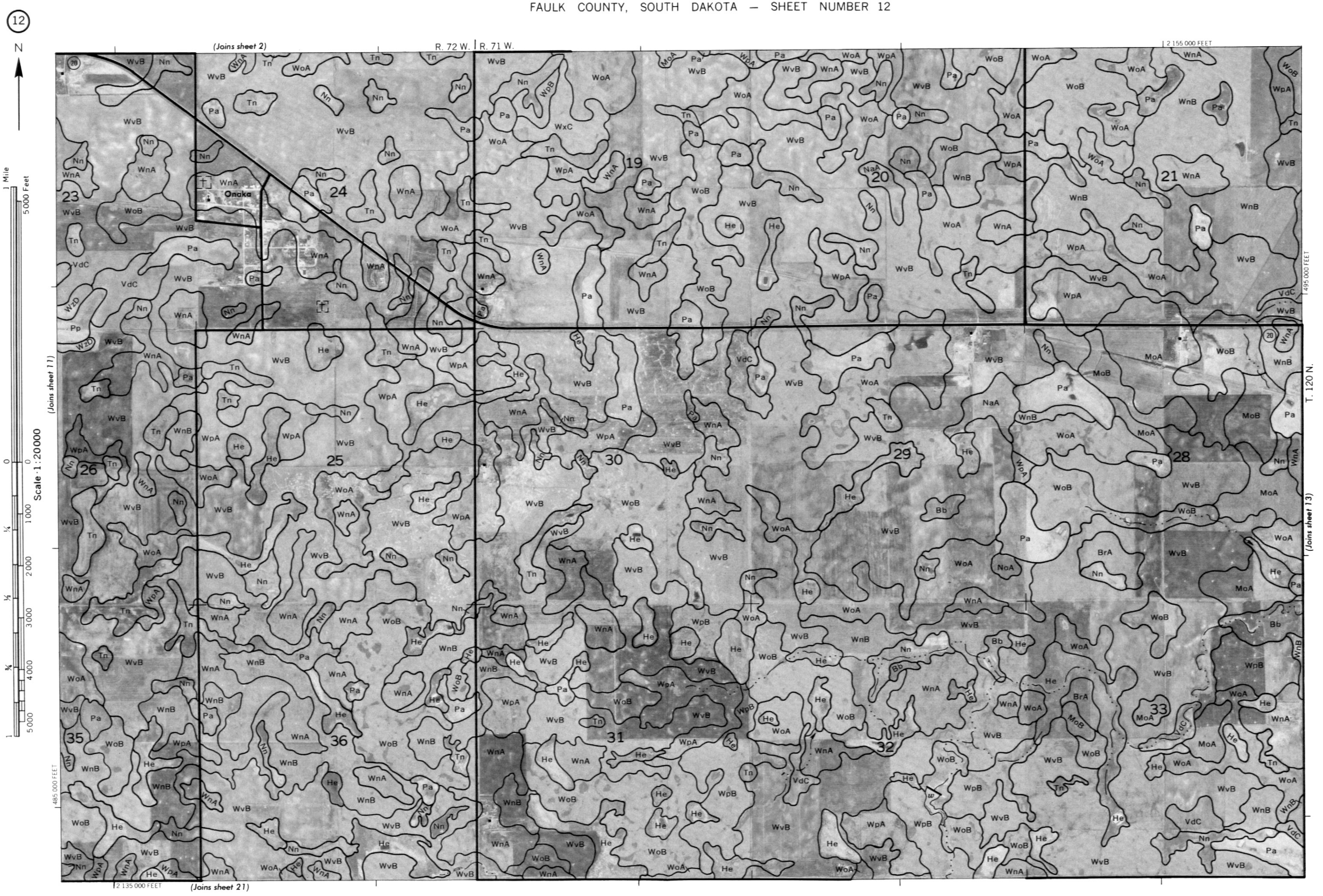

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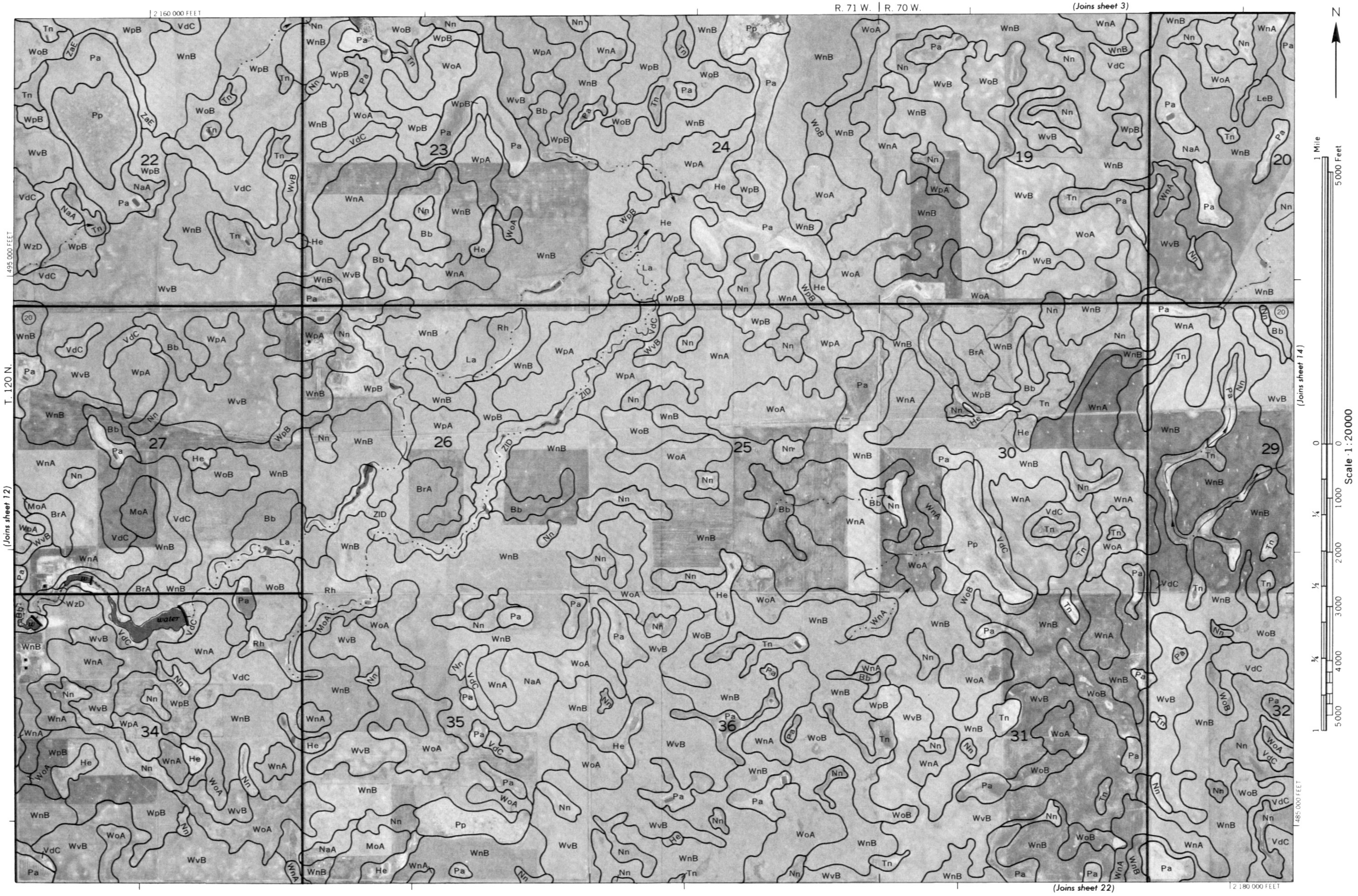

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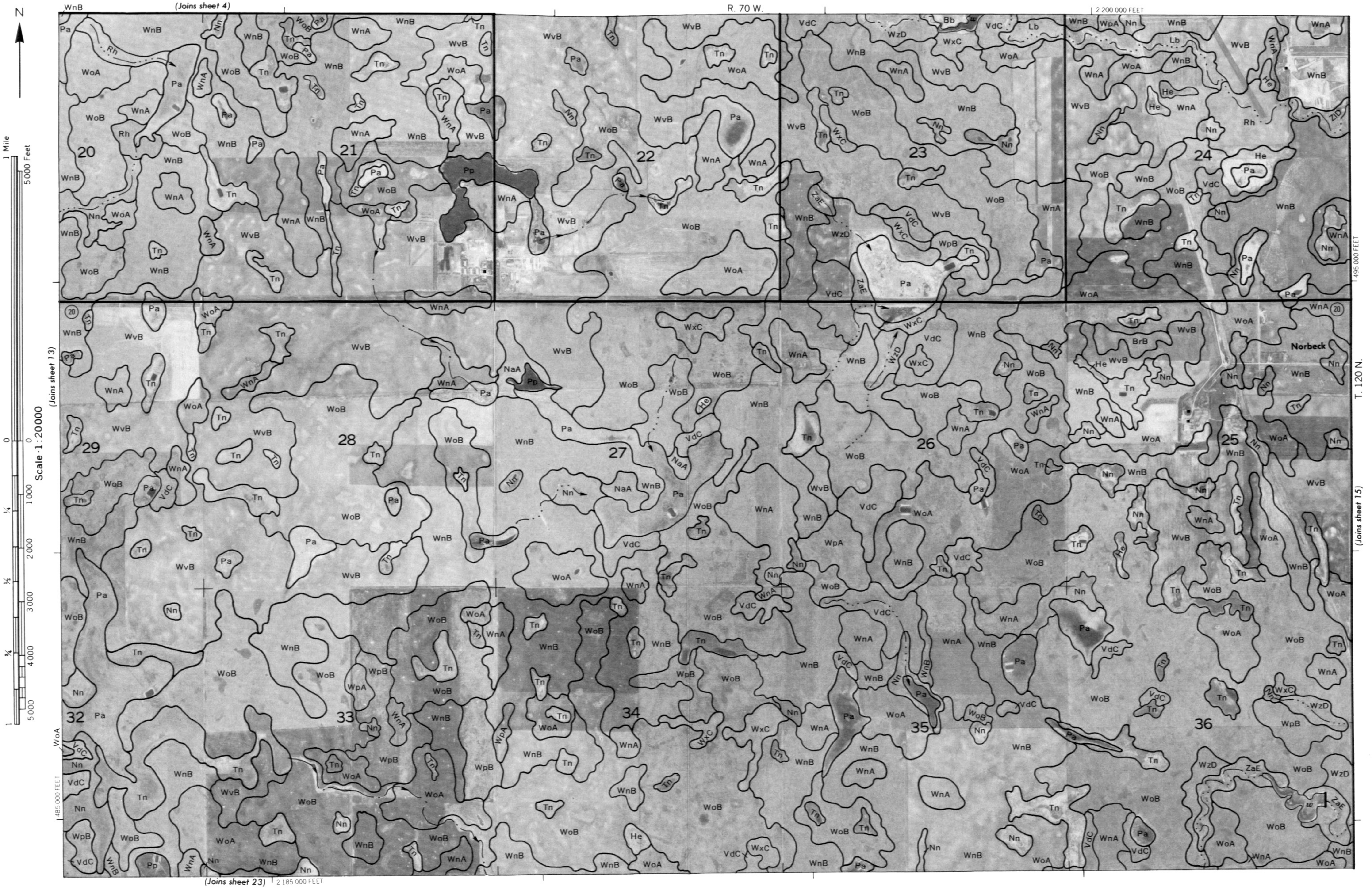

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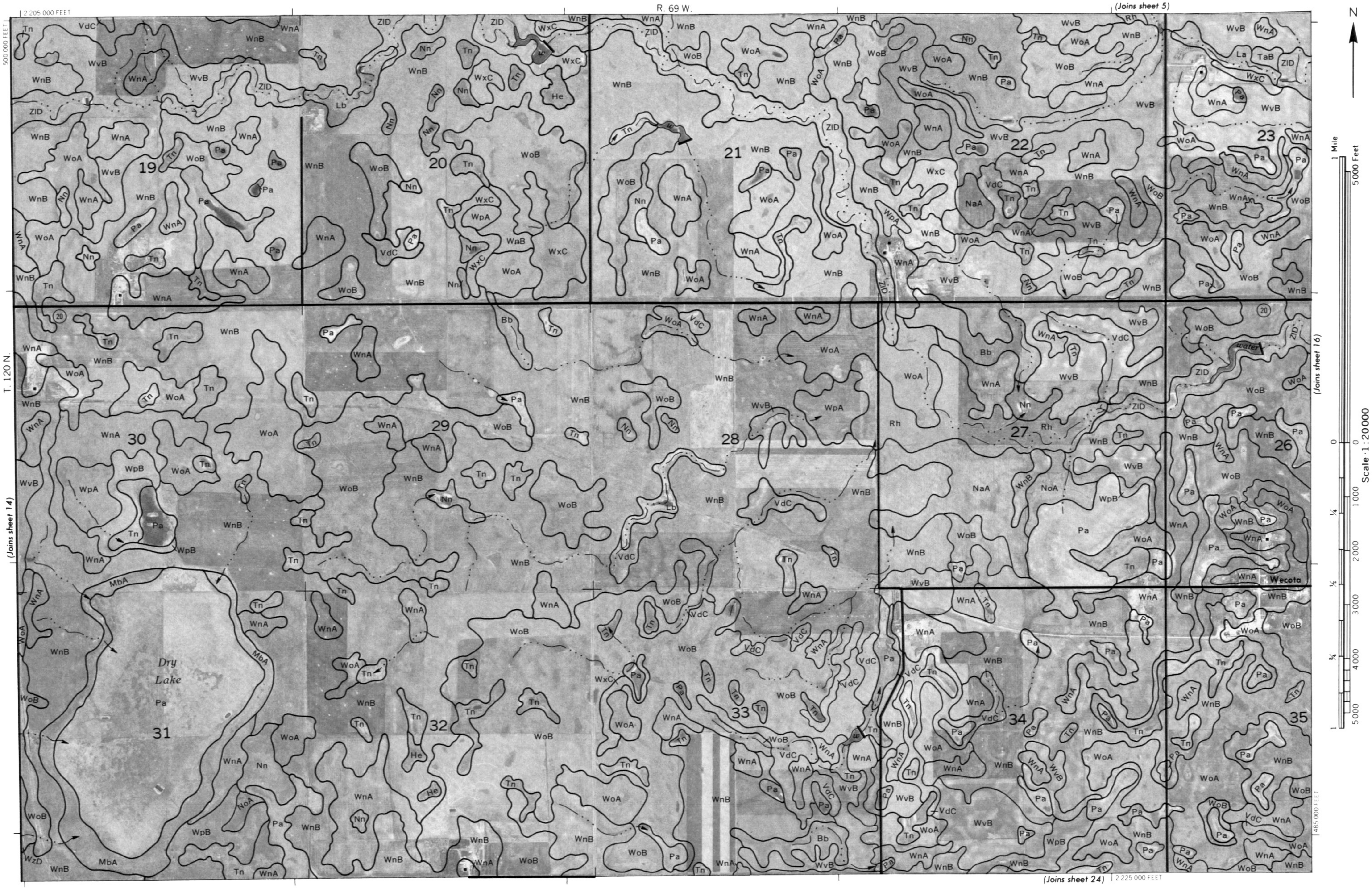

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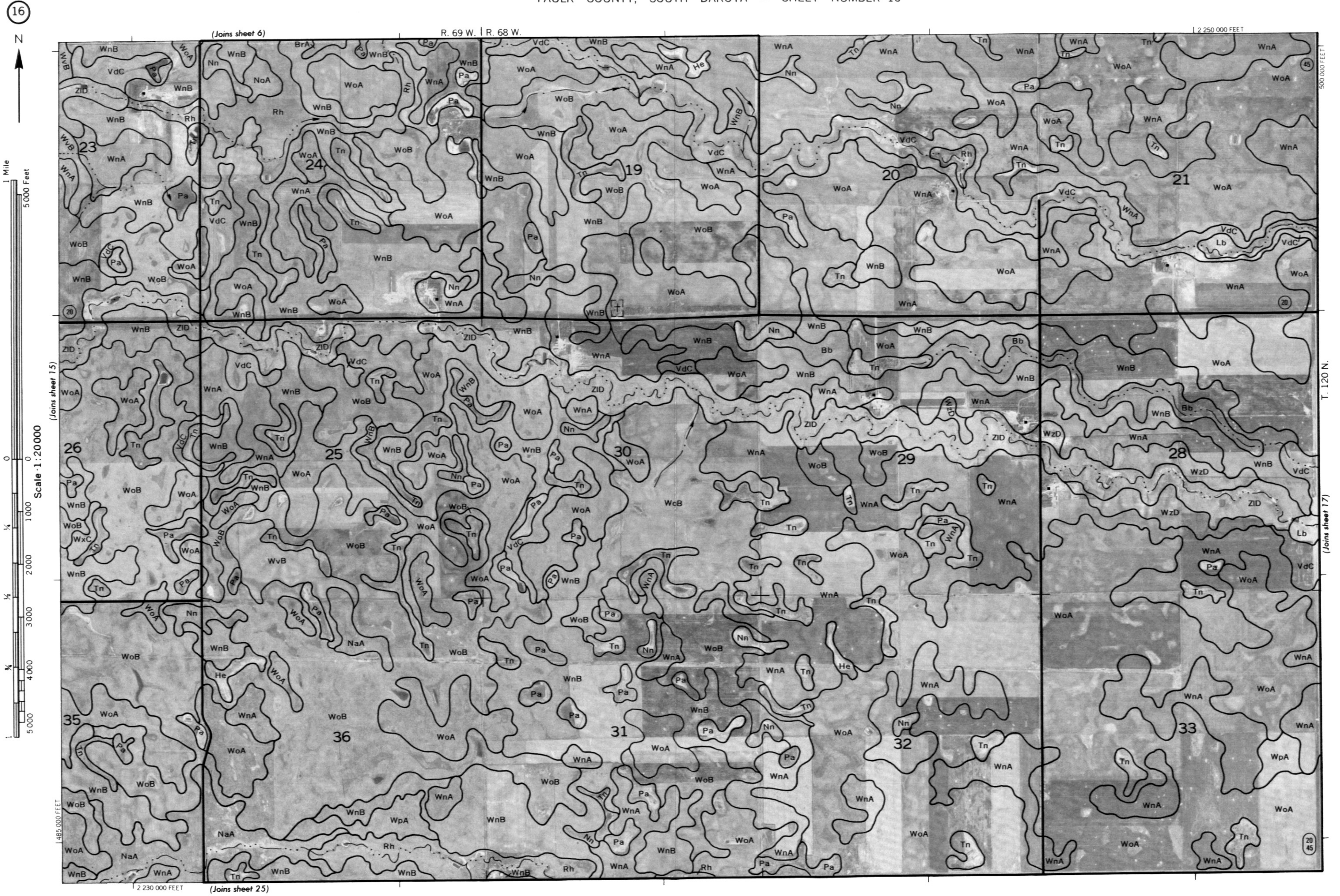

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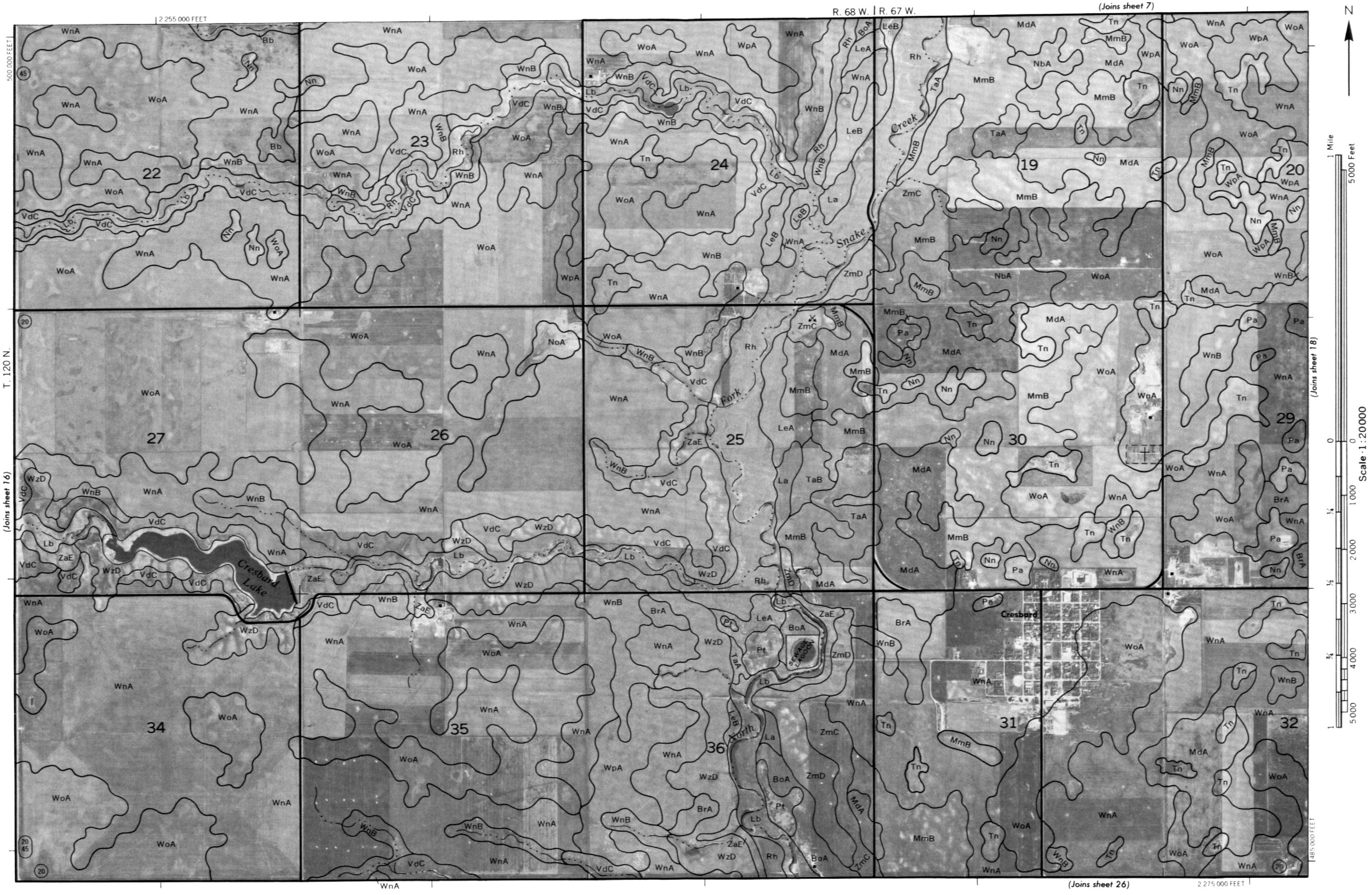

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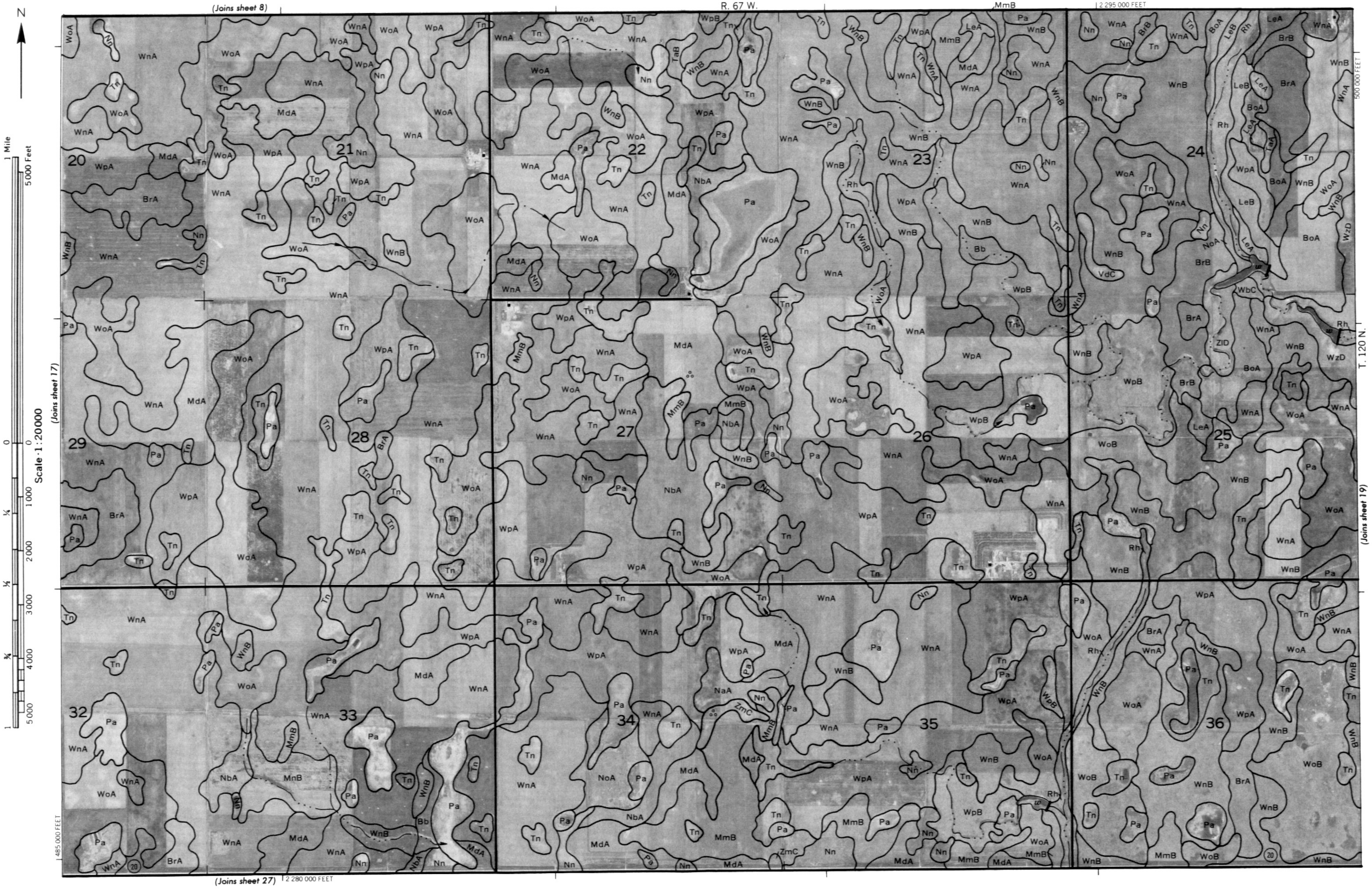

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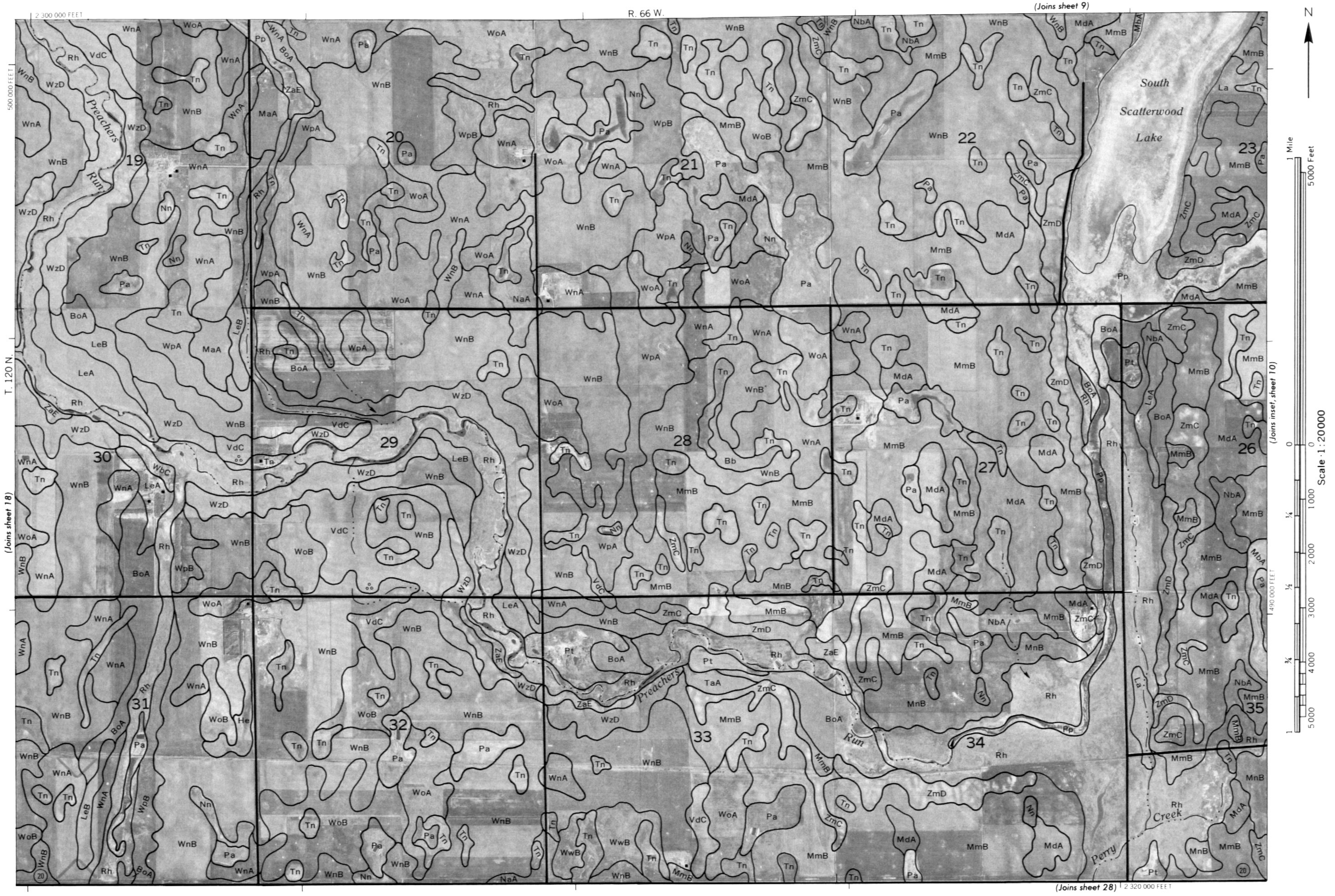

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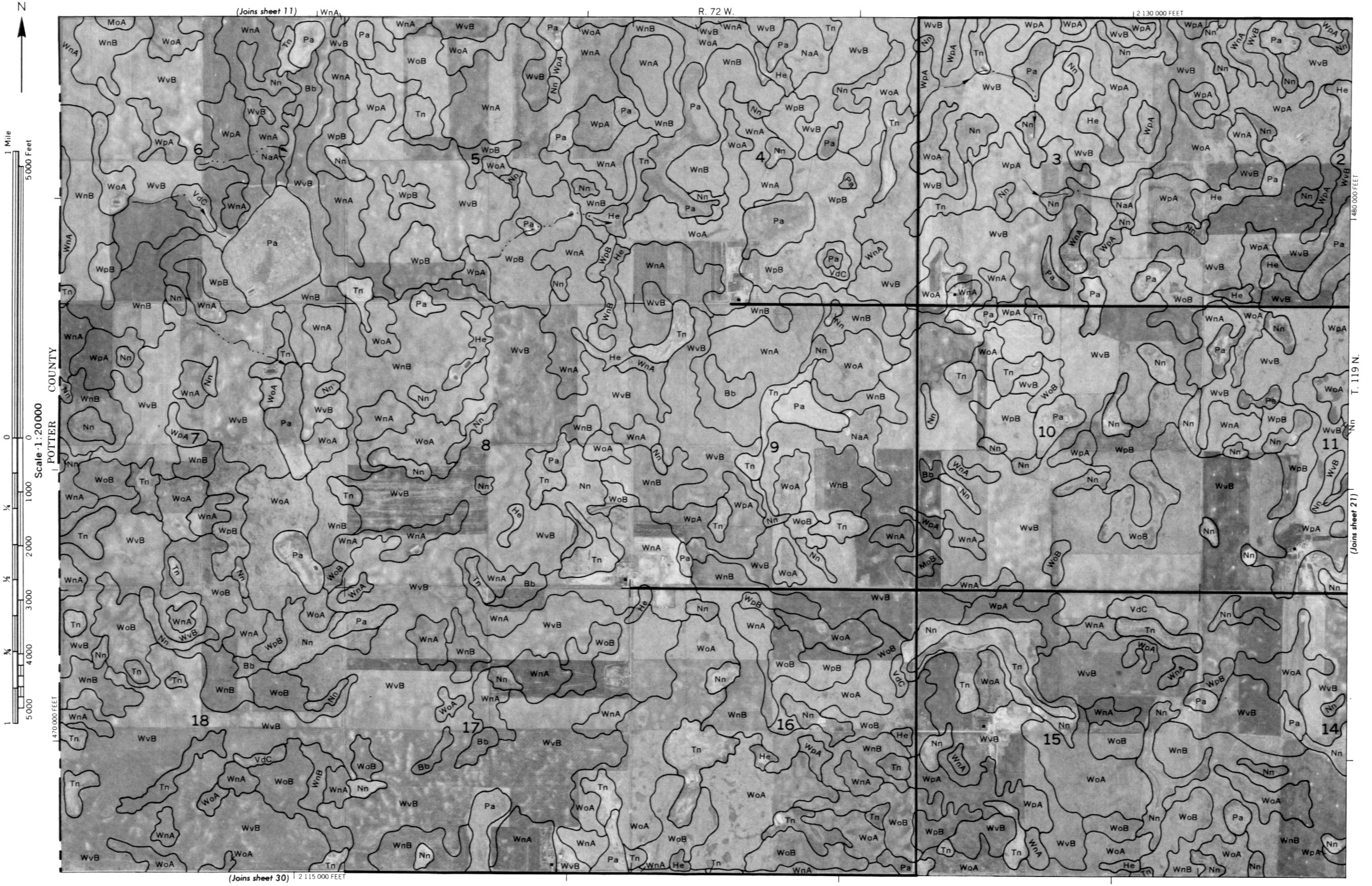

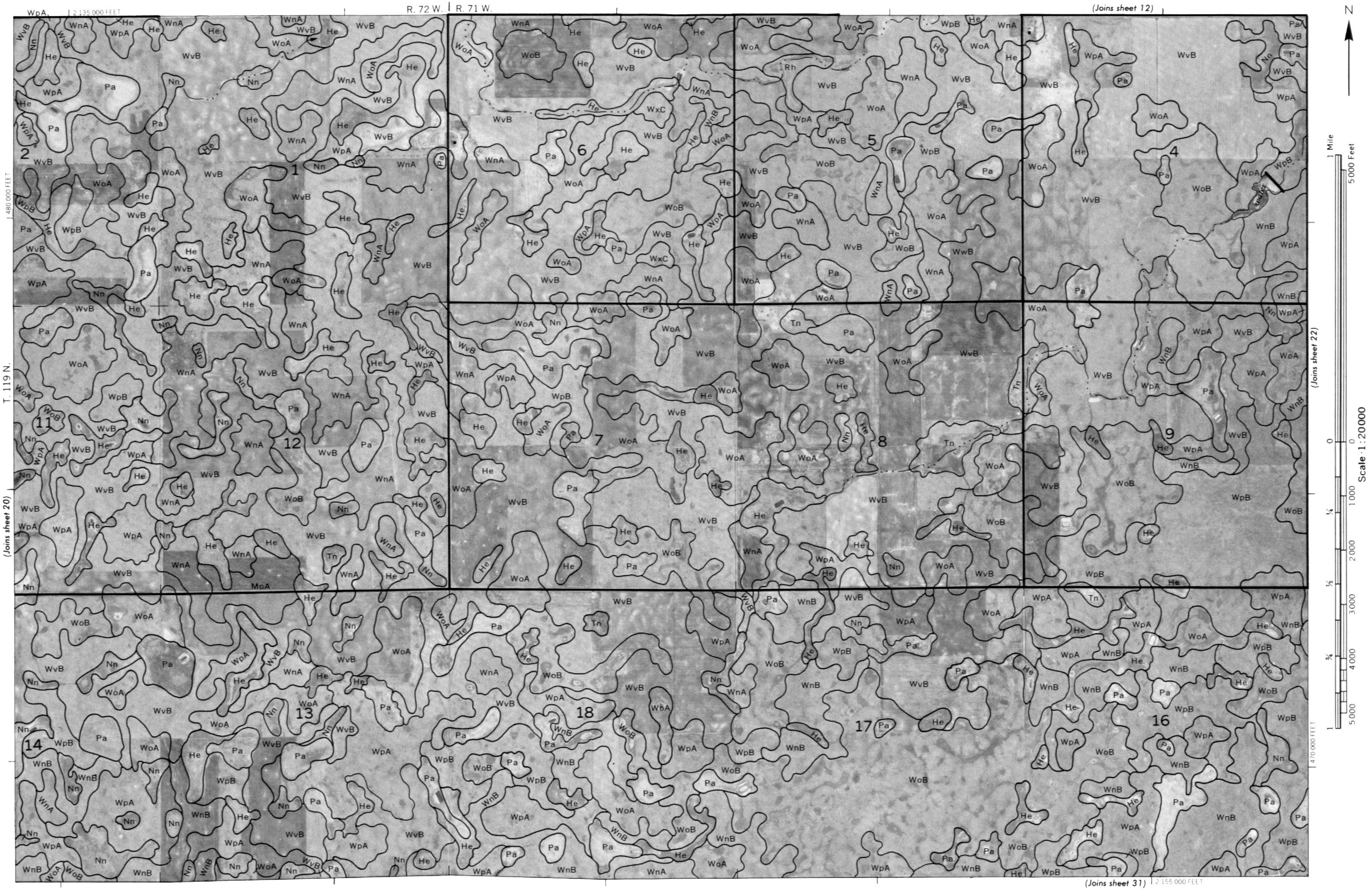
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R. 72 W.
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T. 119 N.
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470 000 FEET
2 155 000 FEET
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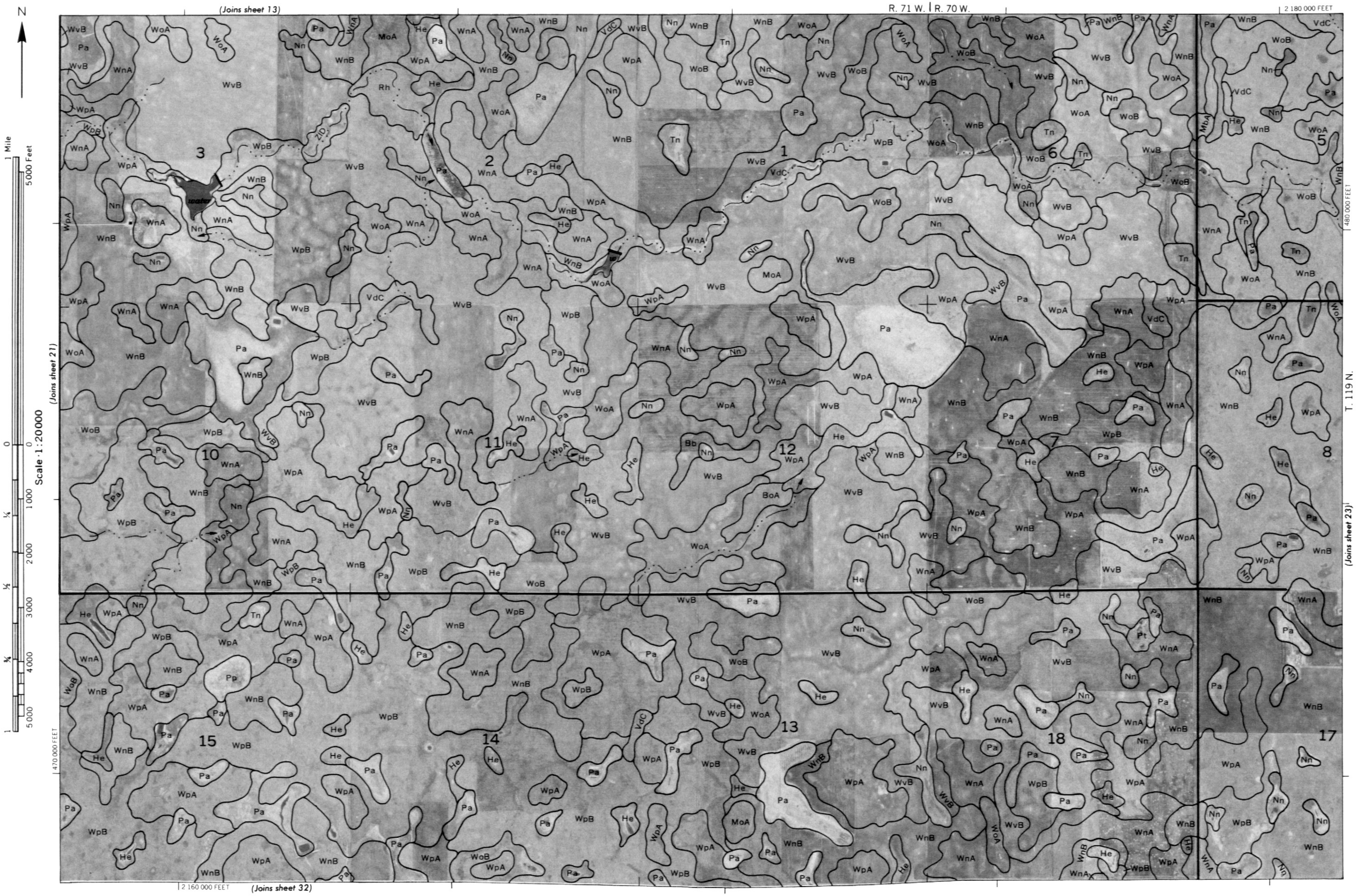

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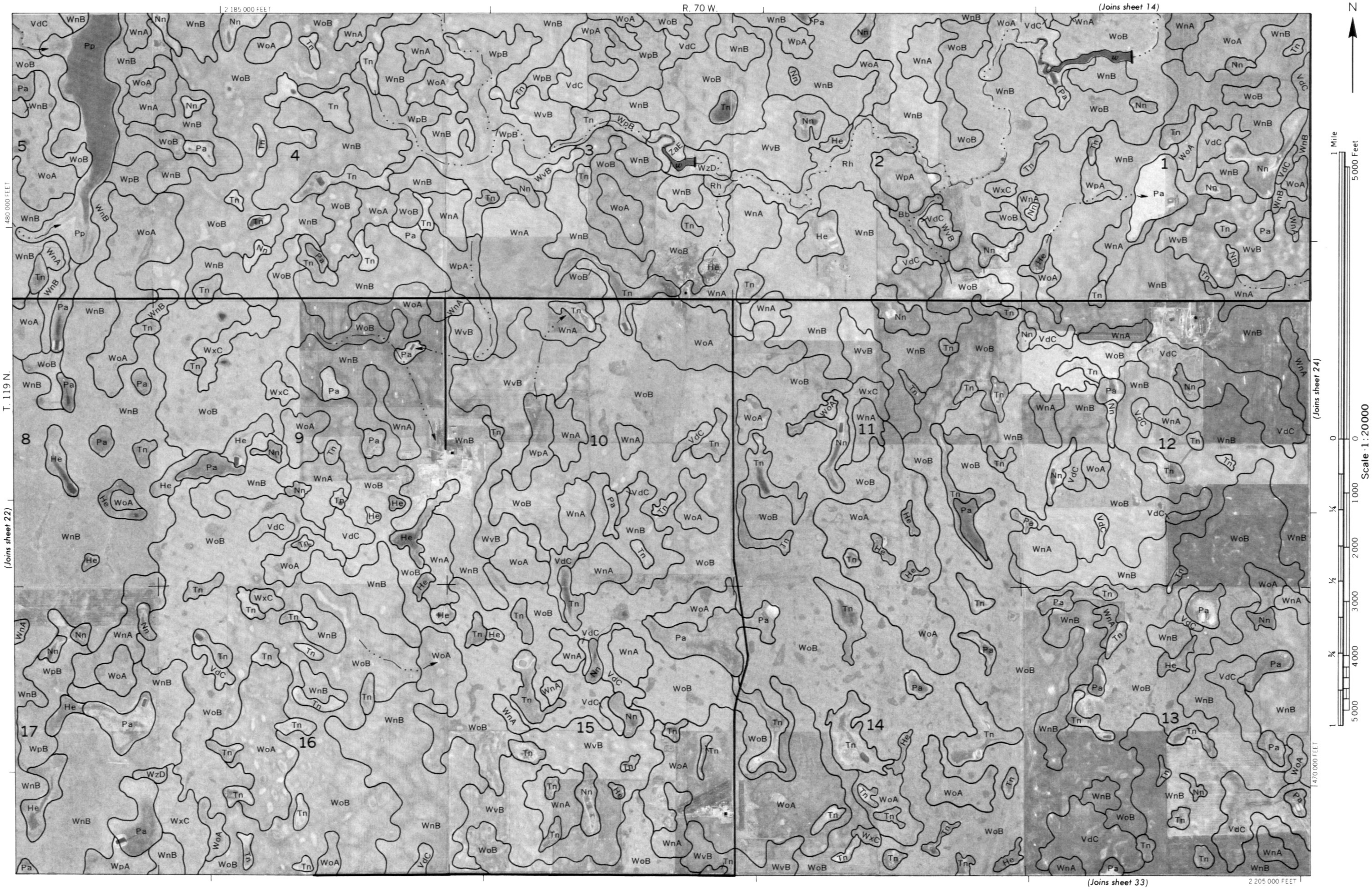

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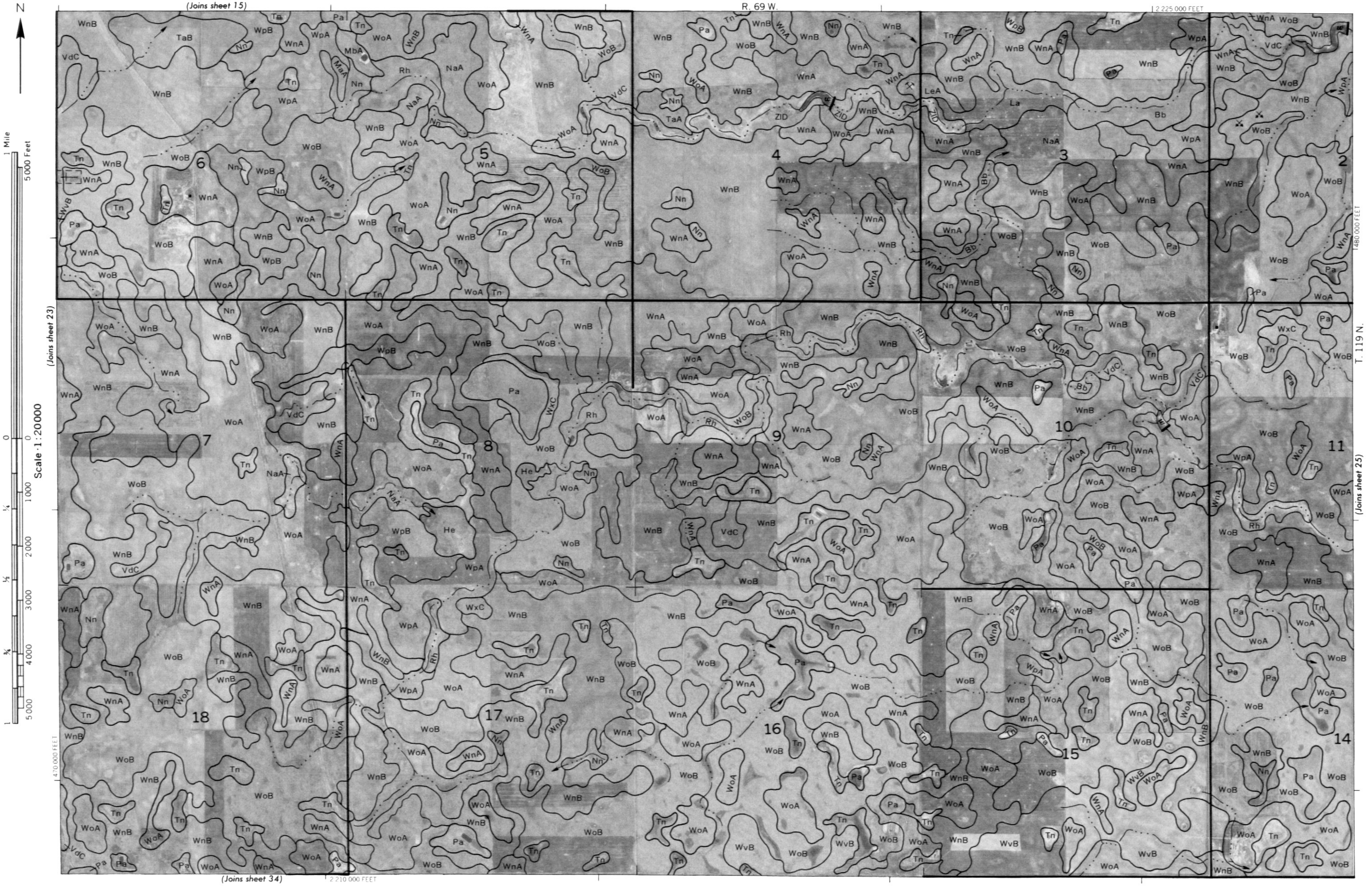

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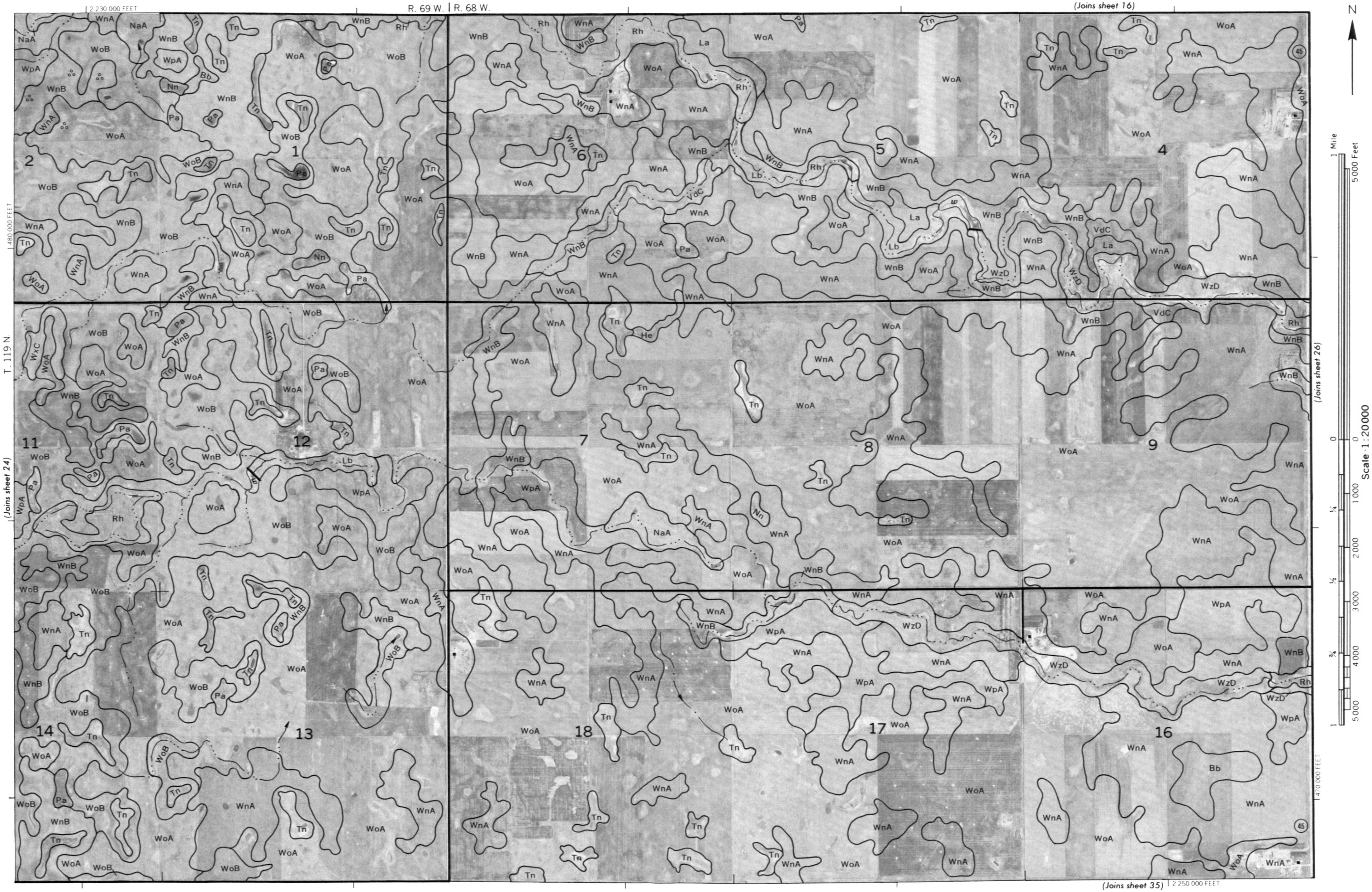

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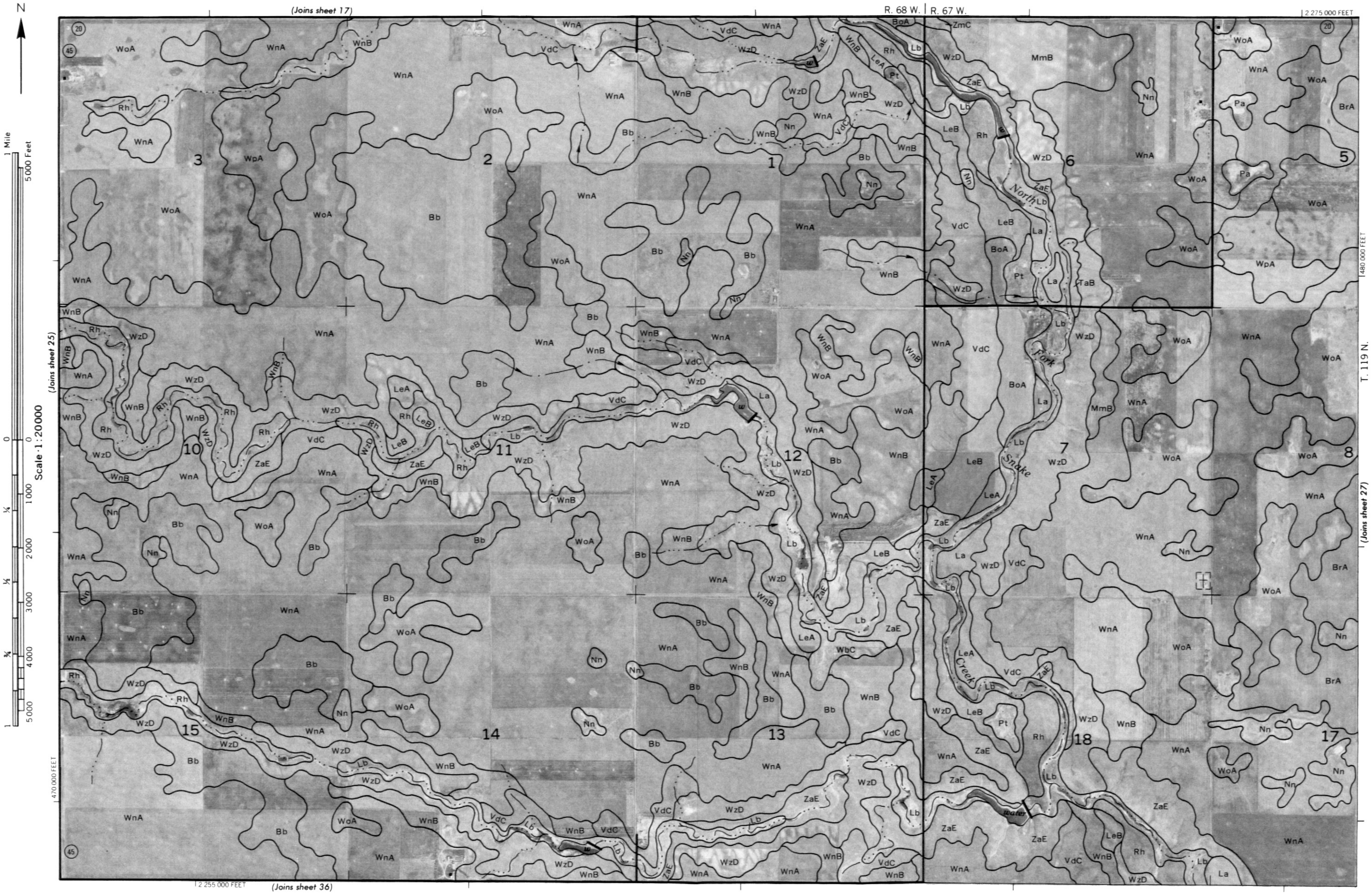

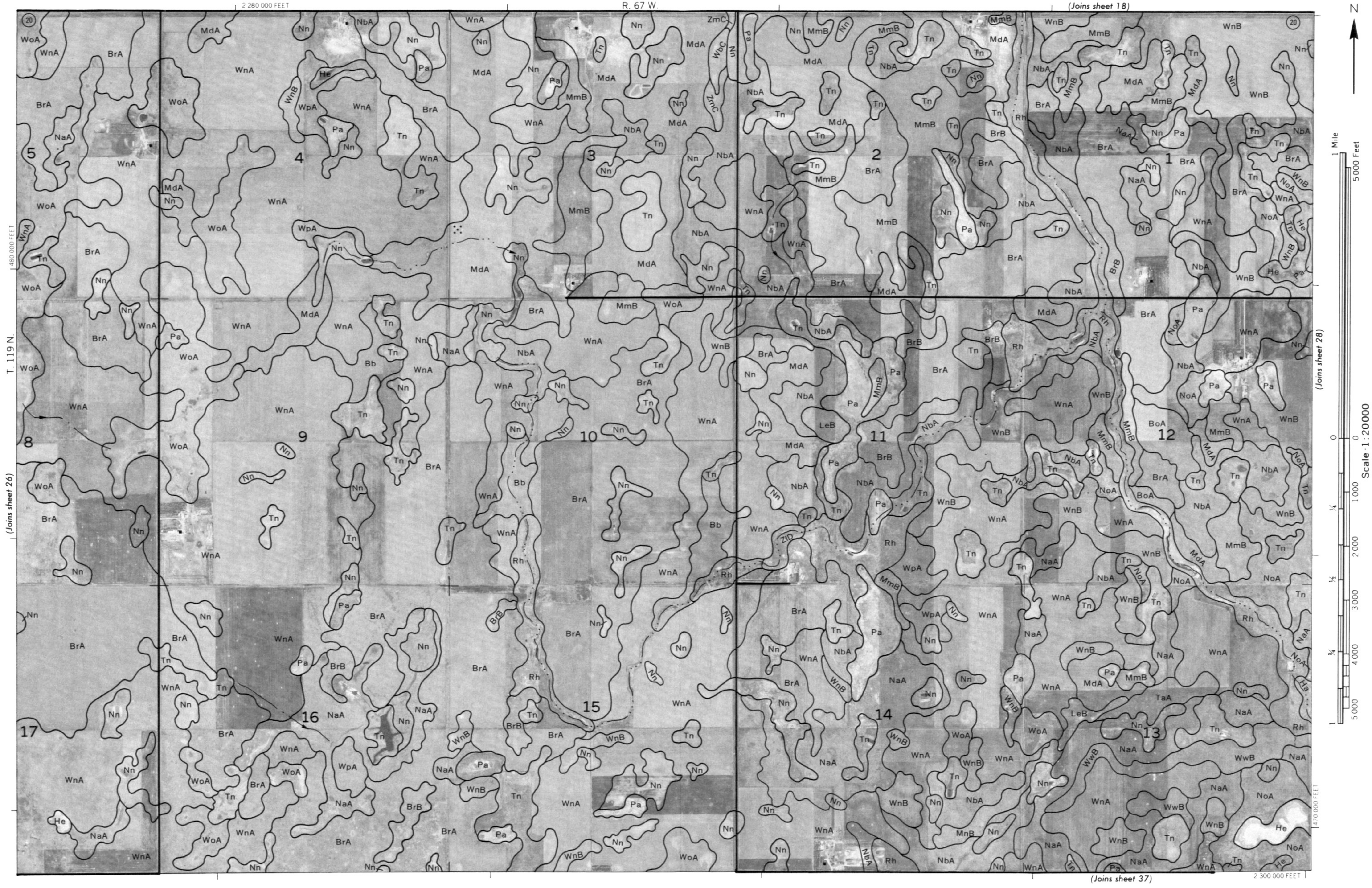
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470 000 FEET
2 300 000 FEET
(Joins sheet 37)
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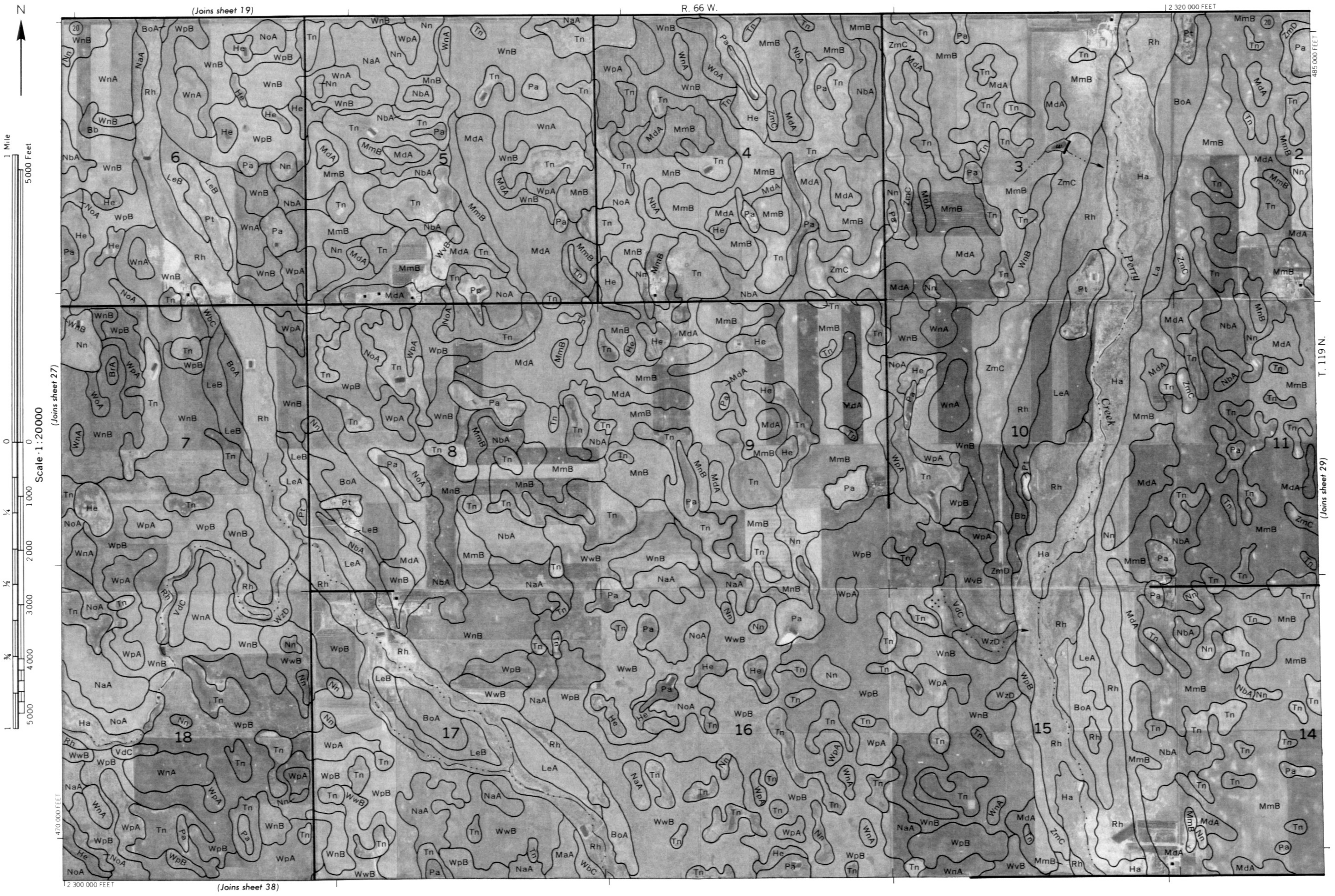

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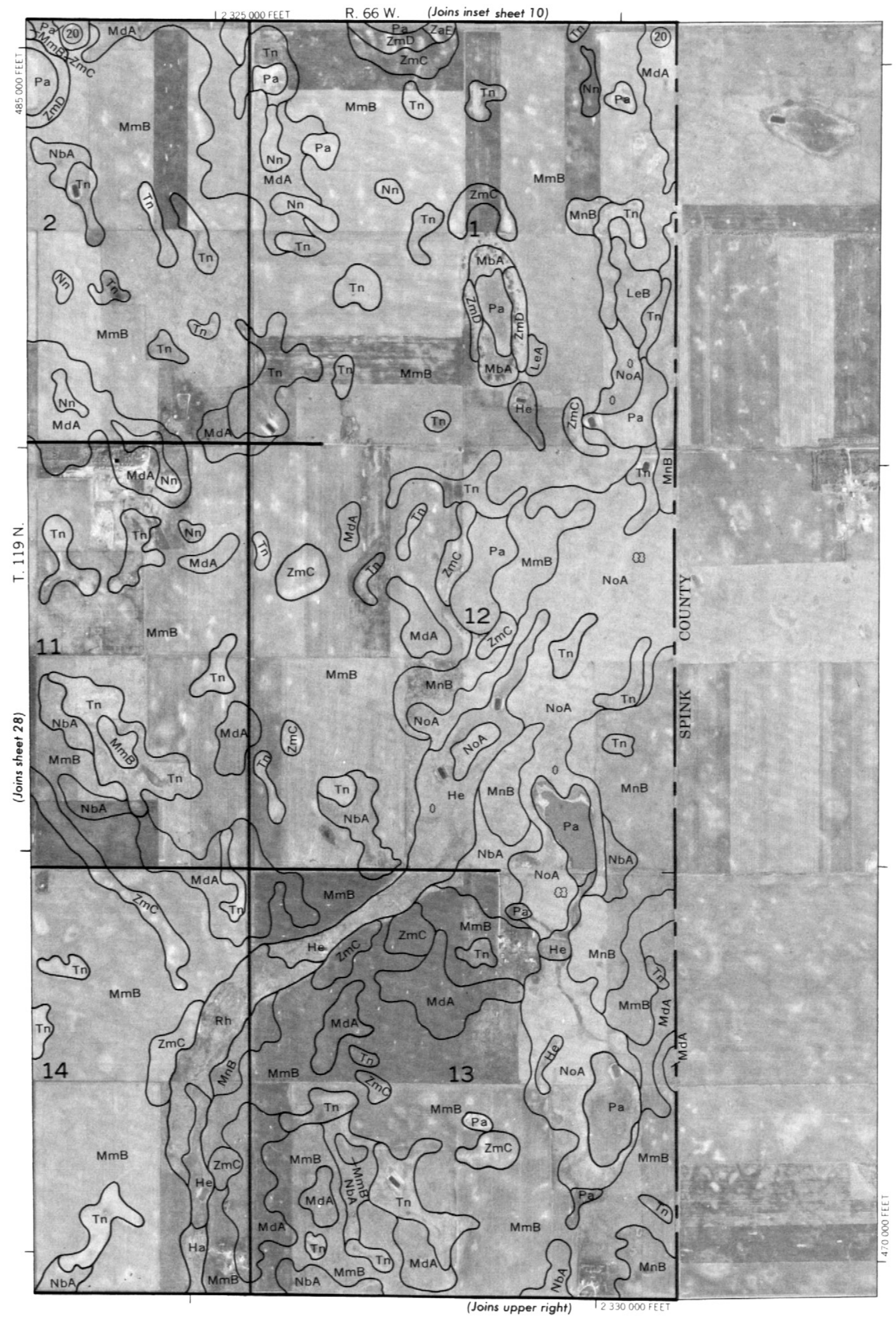

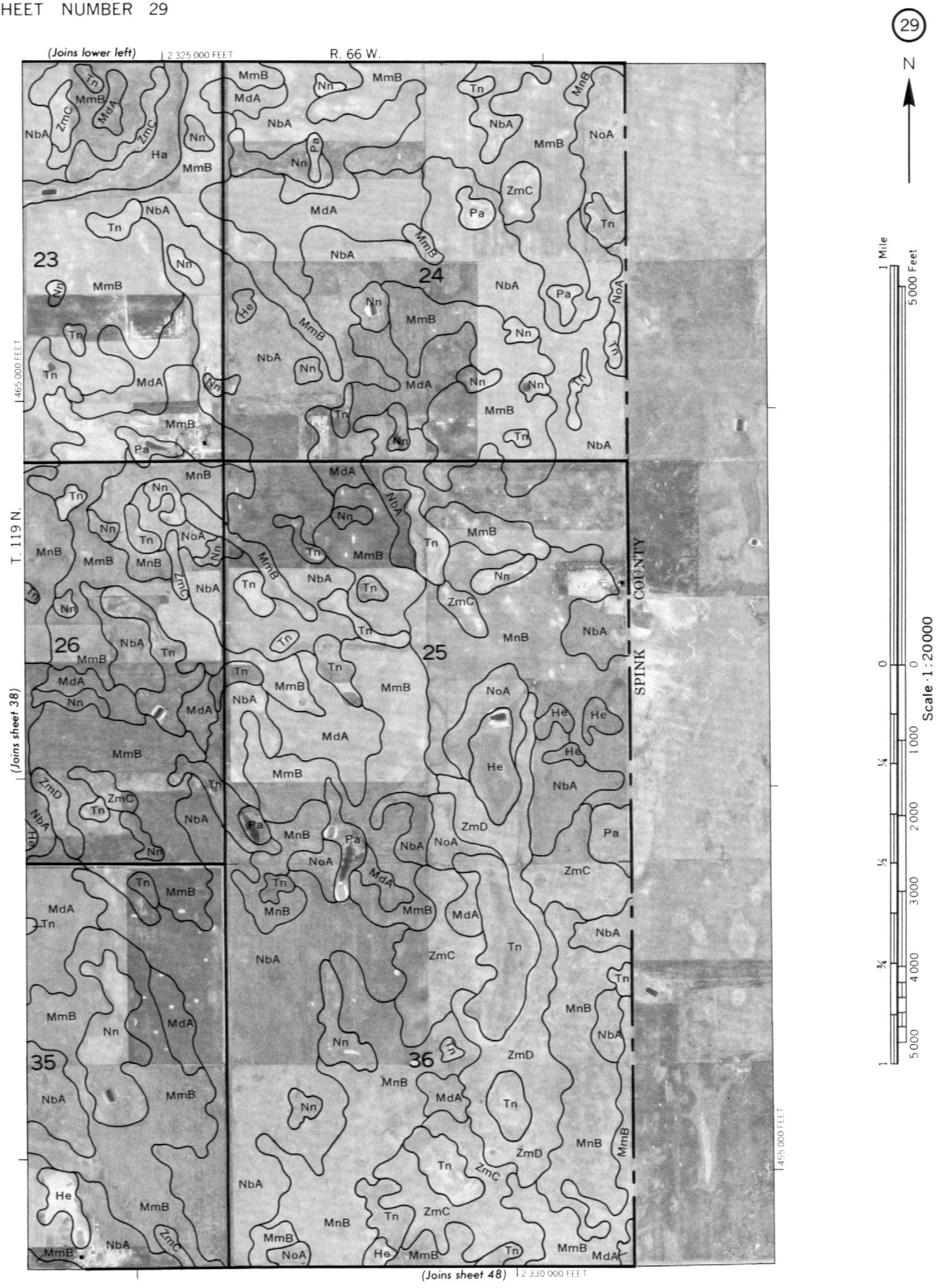

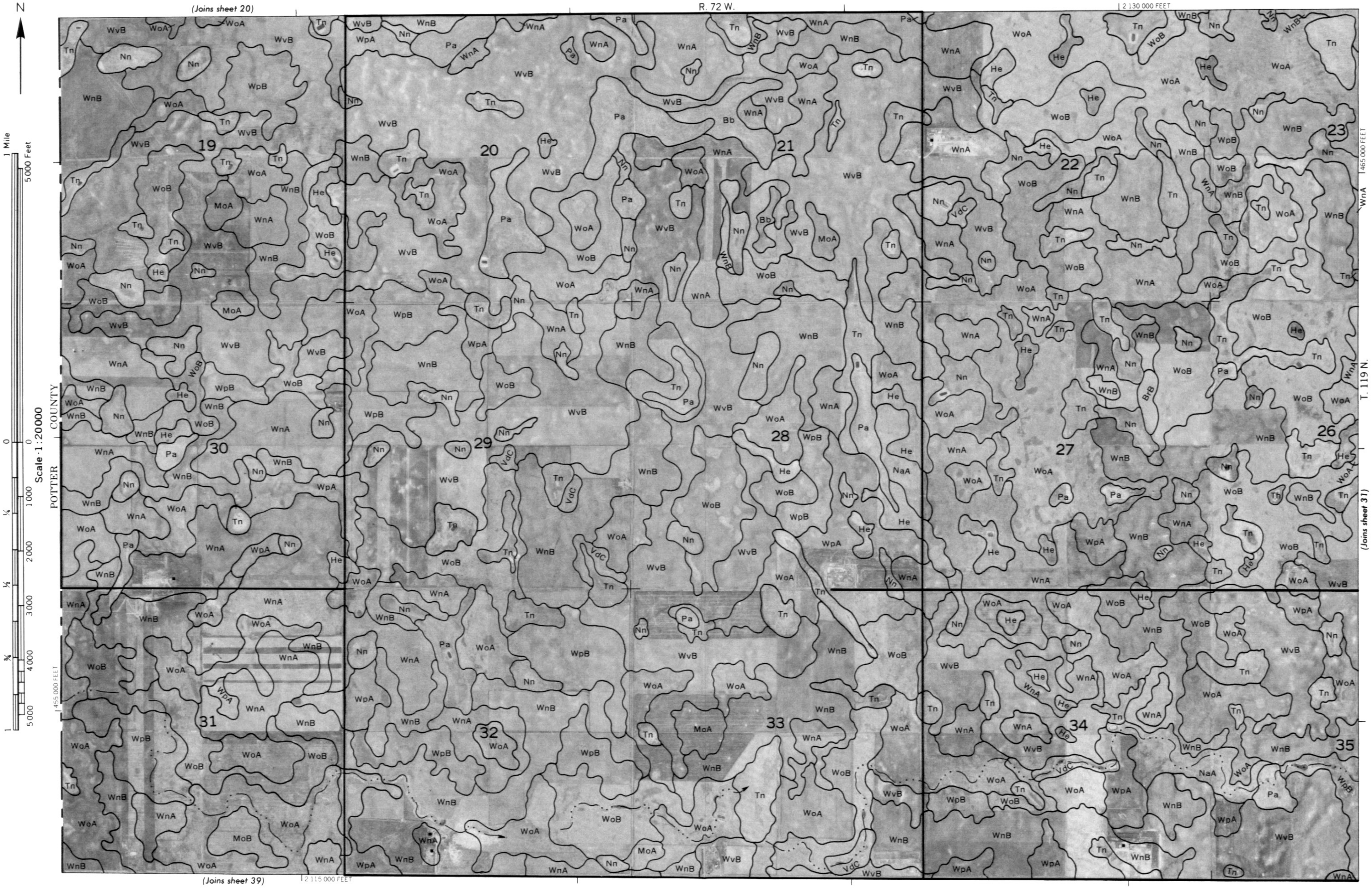
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T. 119 N.
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POTTER COUNTY
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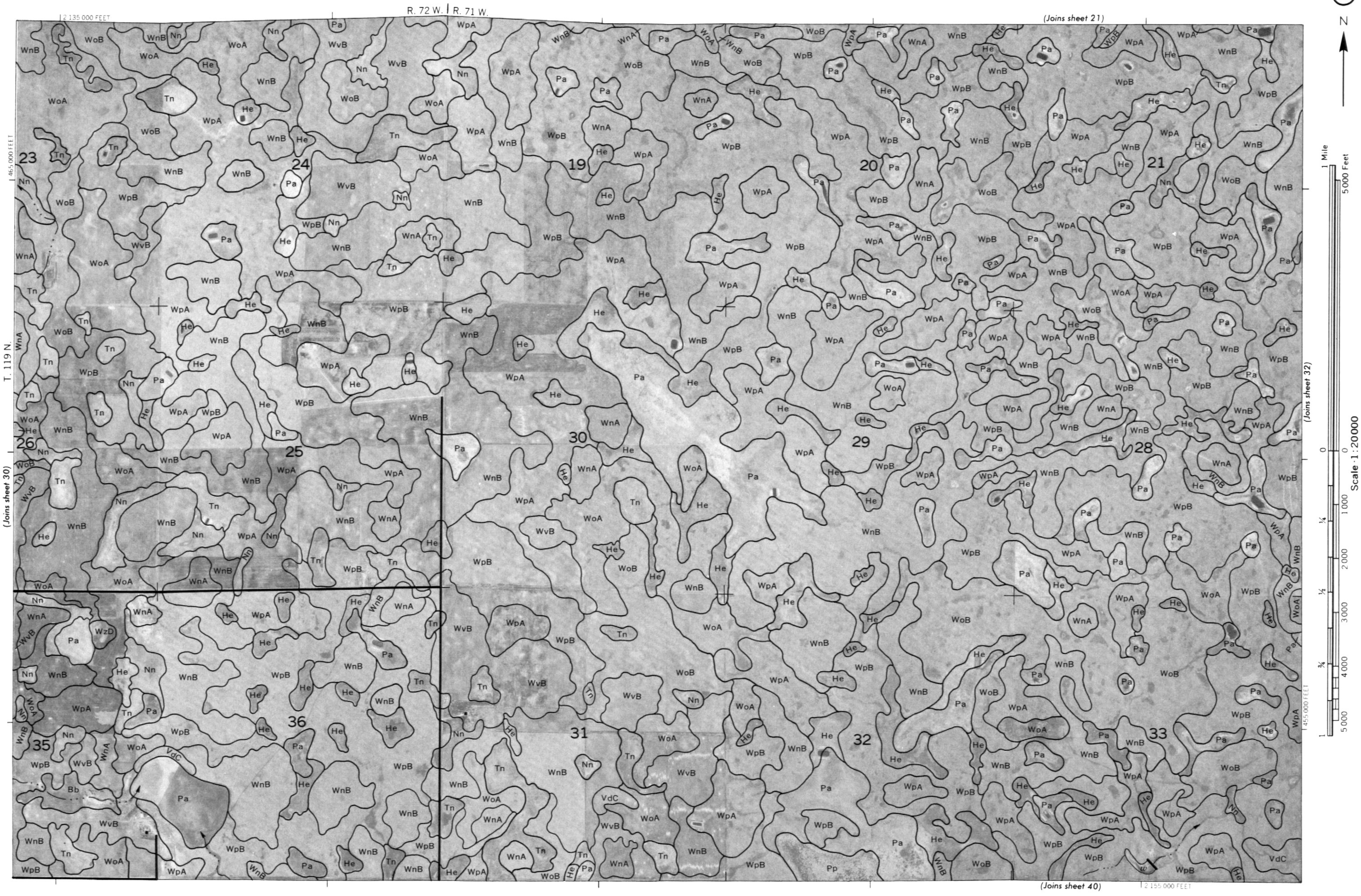

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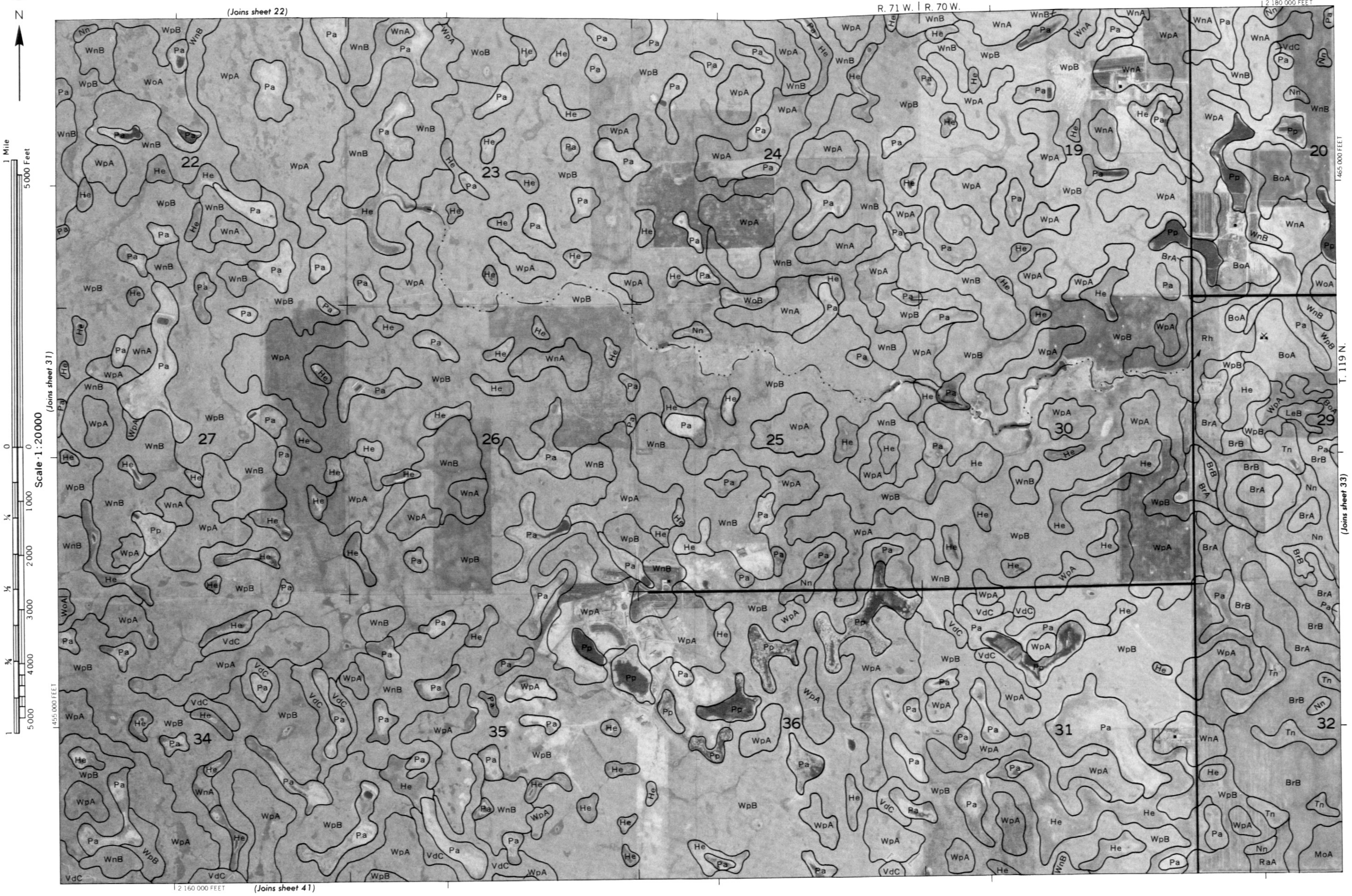

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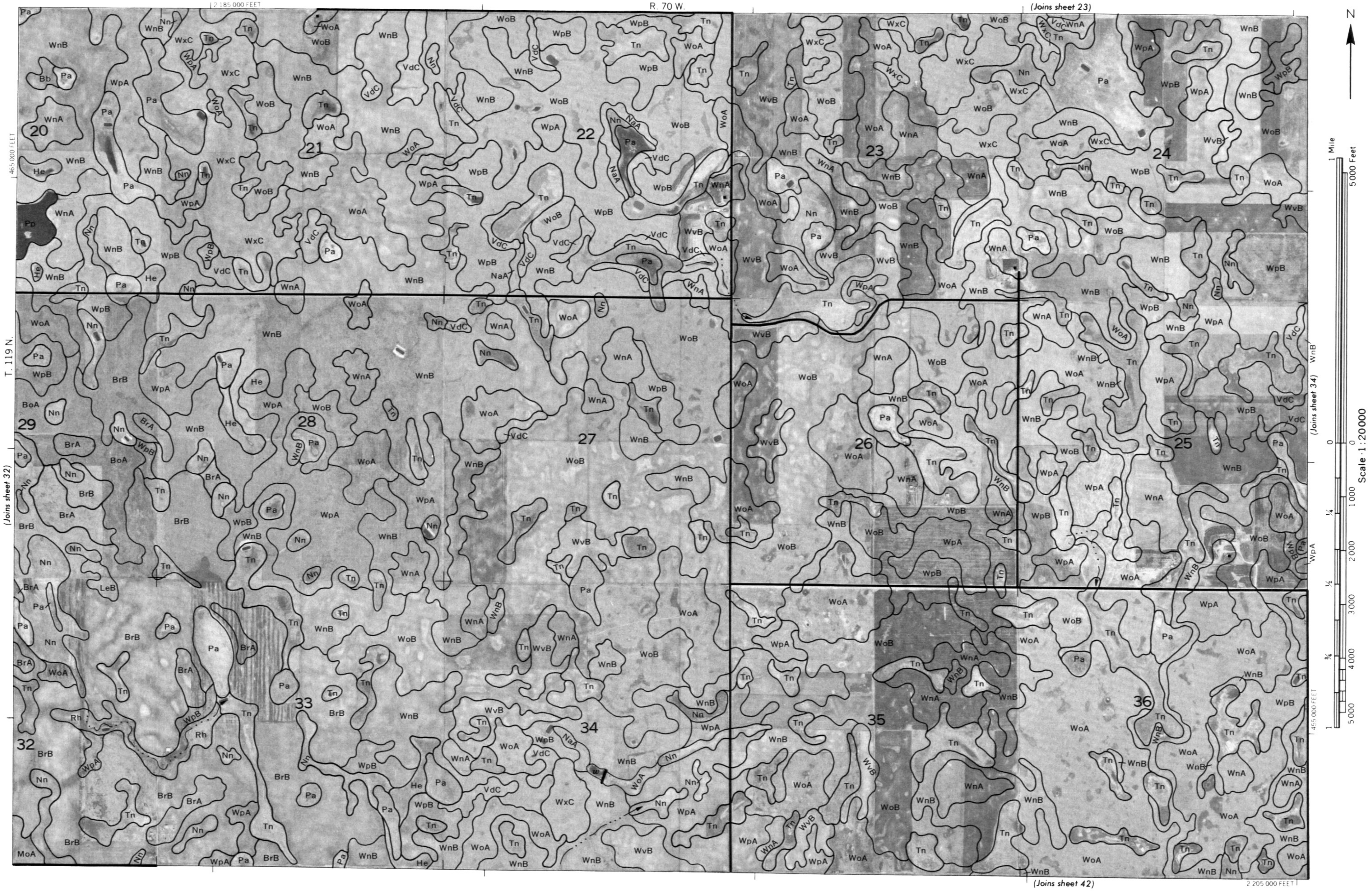

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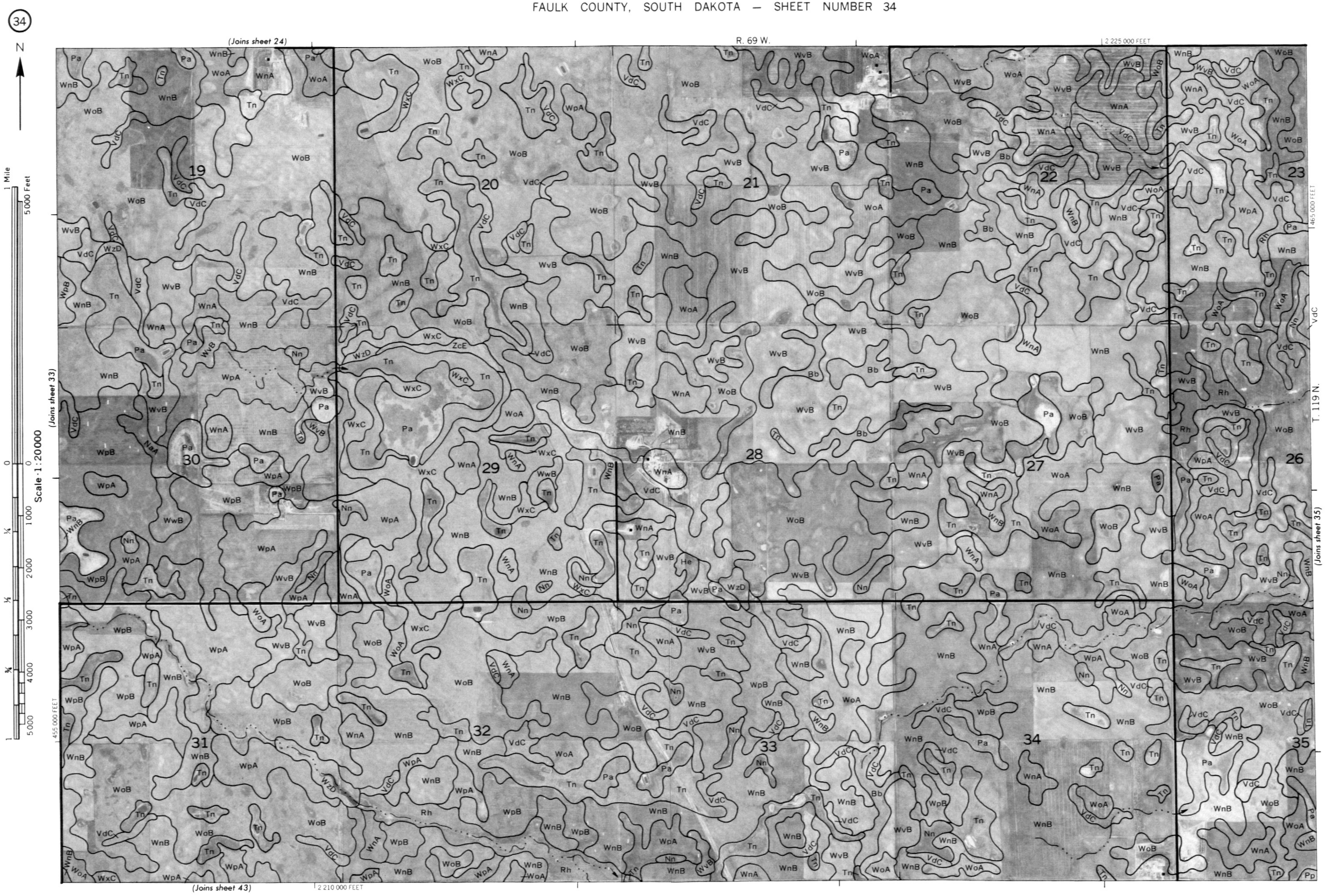

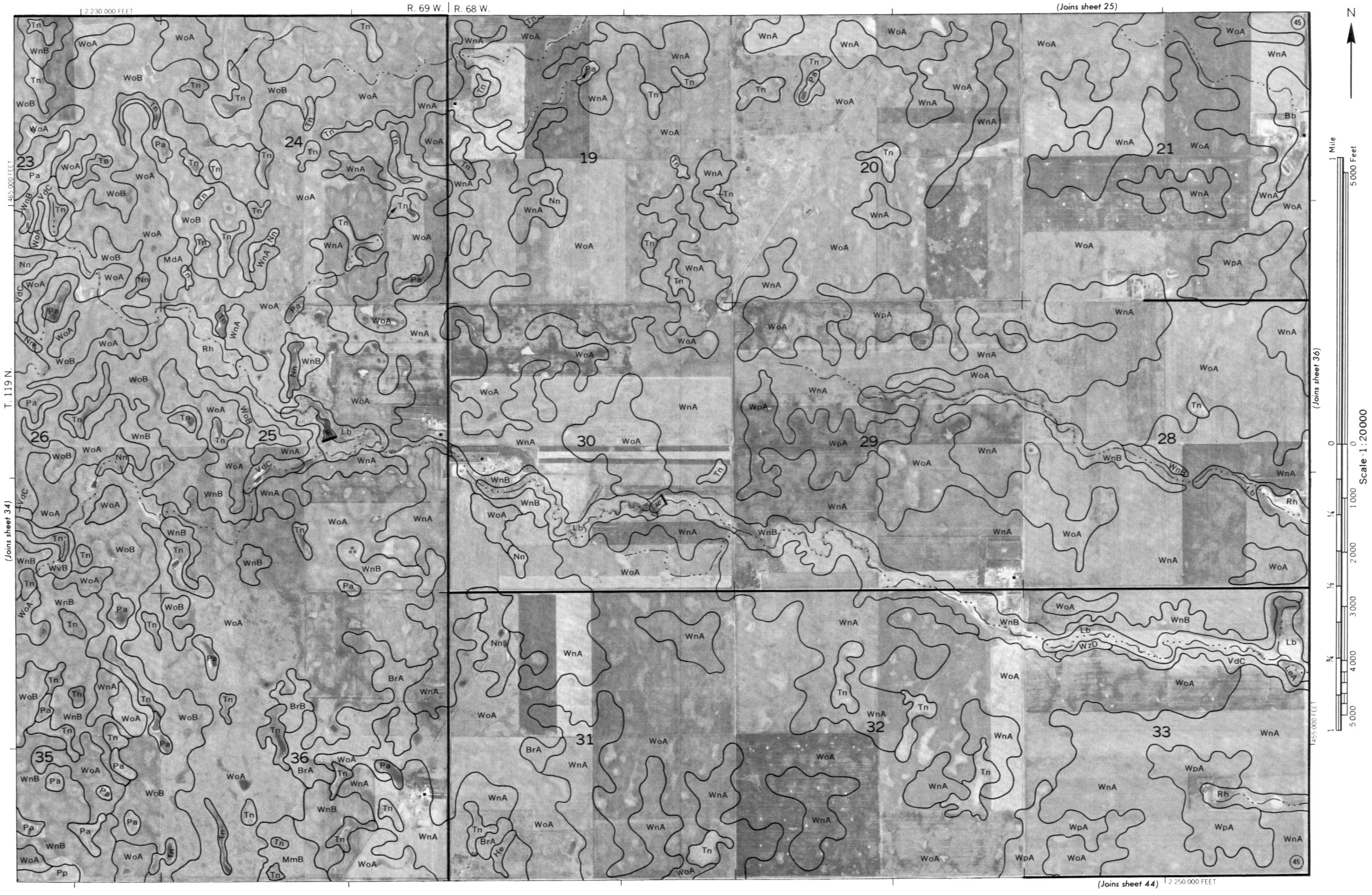

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(Joins sheet 44)
(Joins sheet 34)
R. 69 W.
R. 68 W.
T. 119 N.
2 230 000 FEET
2 250 000 FEET
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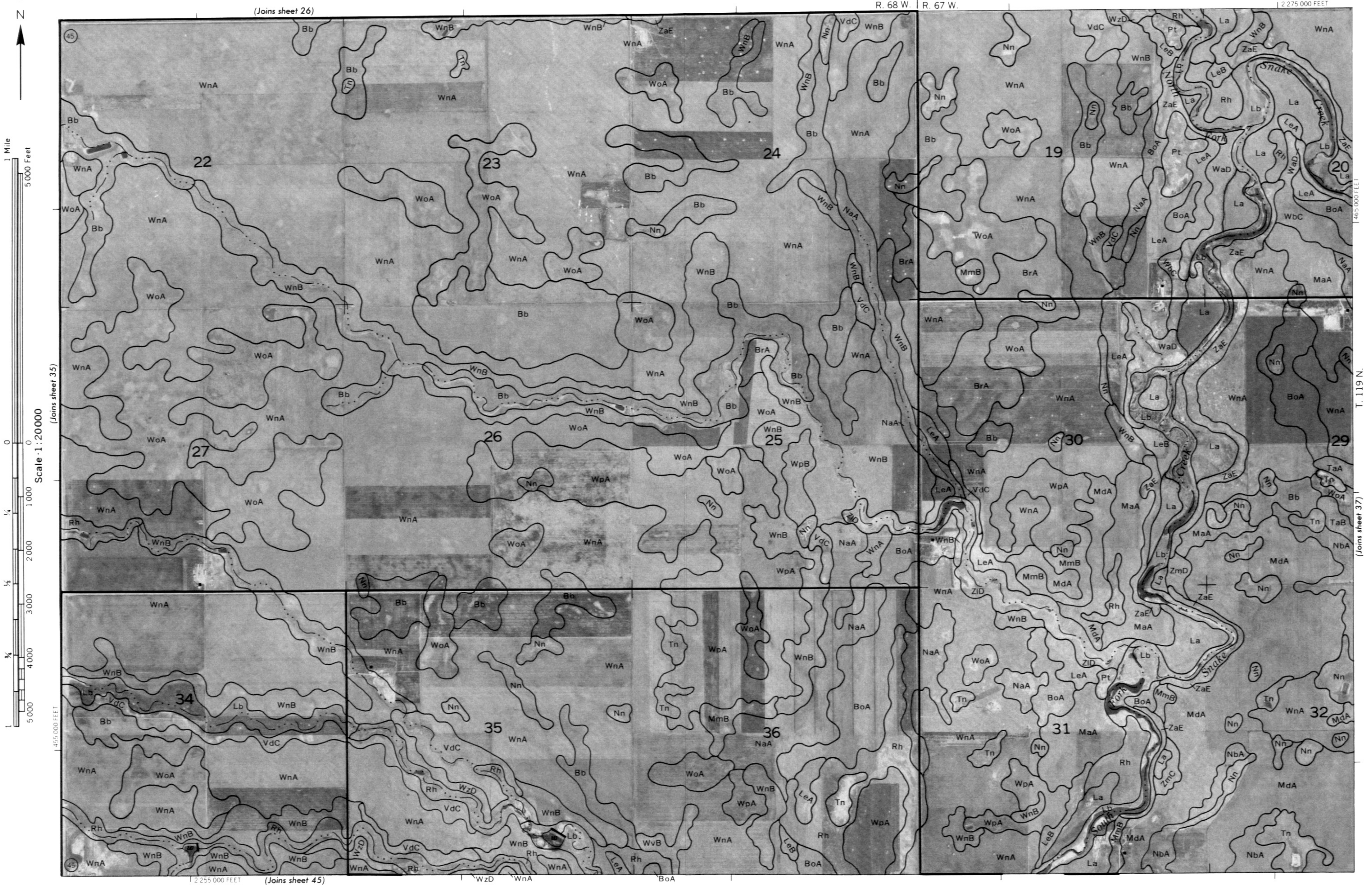
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(Joins sheet 26)
R. 68 W.
R. 67 W.
2 275 000 FEET
465 000 FEET
T. 119 N.
(Joins sheet 35)
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(Joins sheet 45)
2 255 000 FEET
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North Fork
Snake Creek
Creek
Snake
South Fork
Bb
WnA
WnB
WoA
Nn
Tn
ZaE
VdC
BrA
NaA
LeA
LeB
La
Lb
Rh
Pt
WaD
WzD
BoA
WbC
MaA
MdA
MmB
WpA
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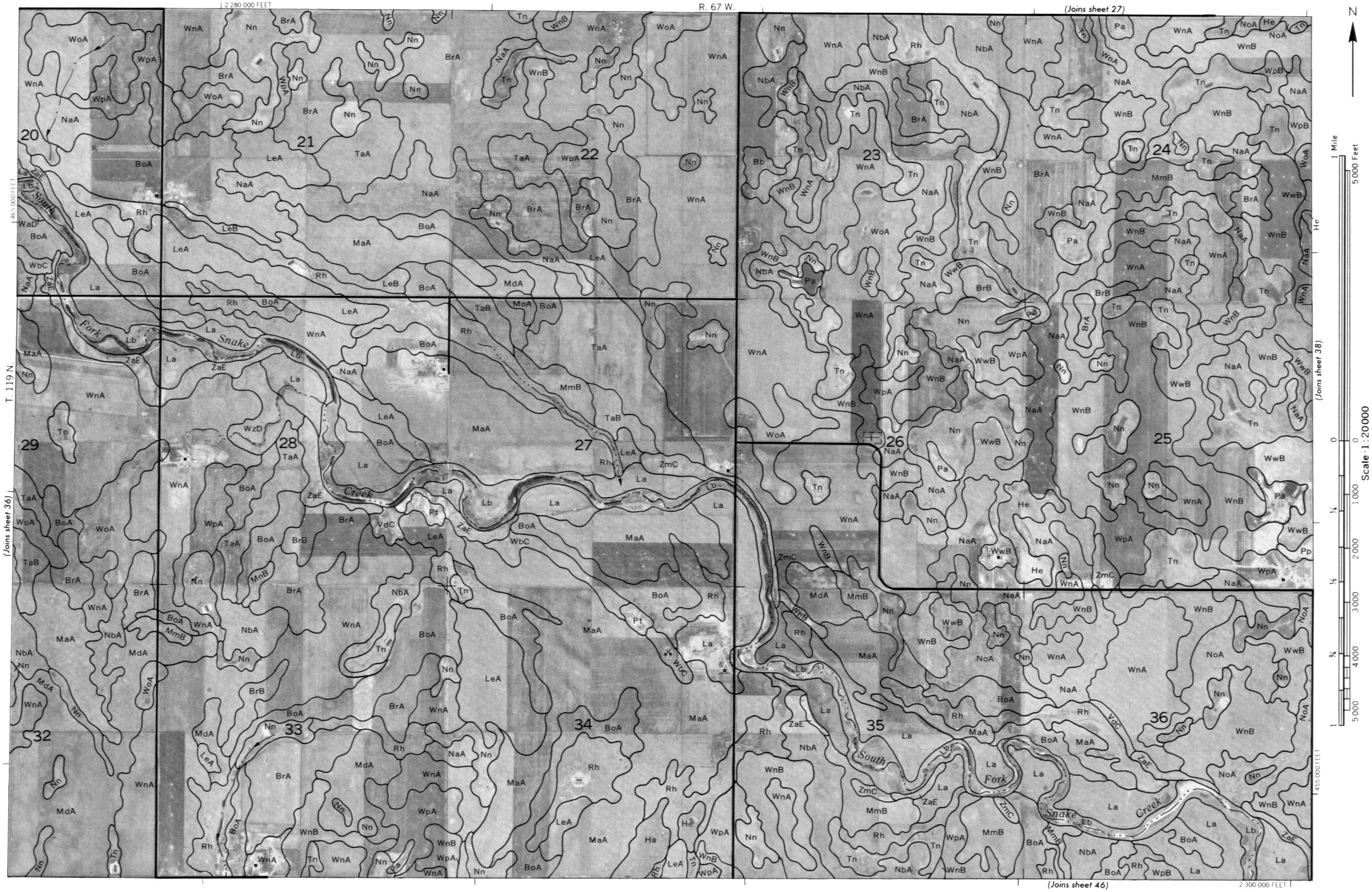
ZlD
WvB
ZaE

FAULK COUNTY, SOUTH DAKOTA — SHEET NUMBER 37



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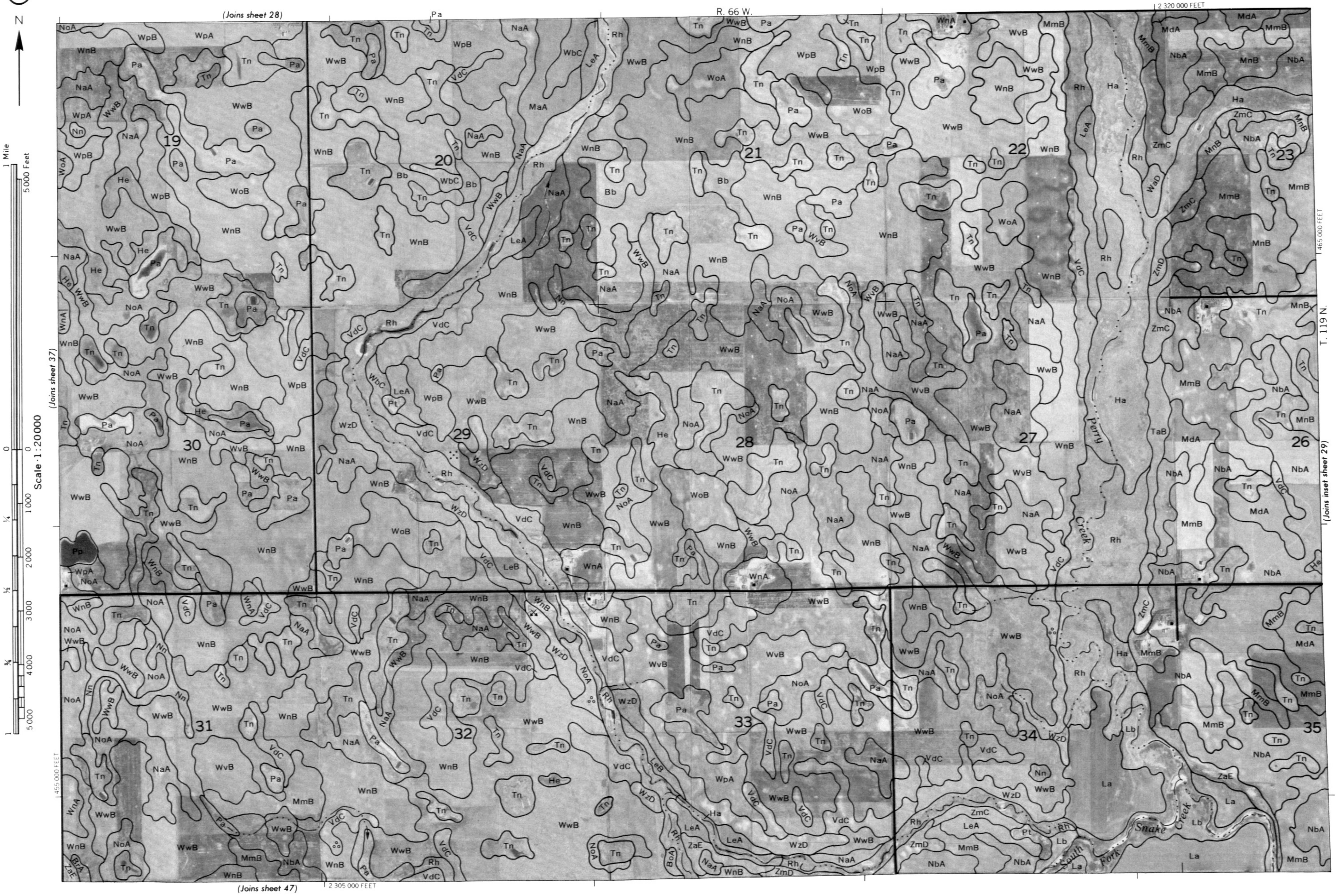

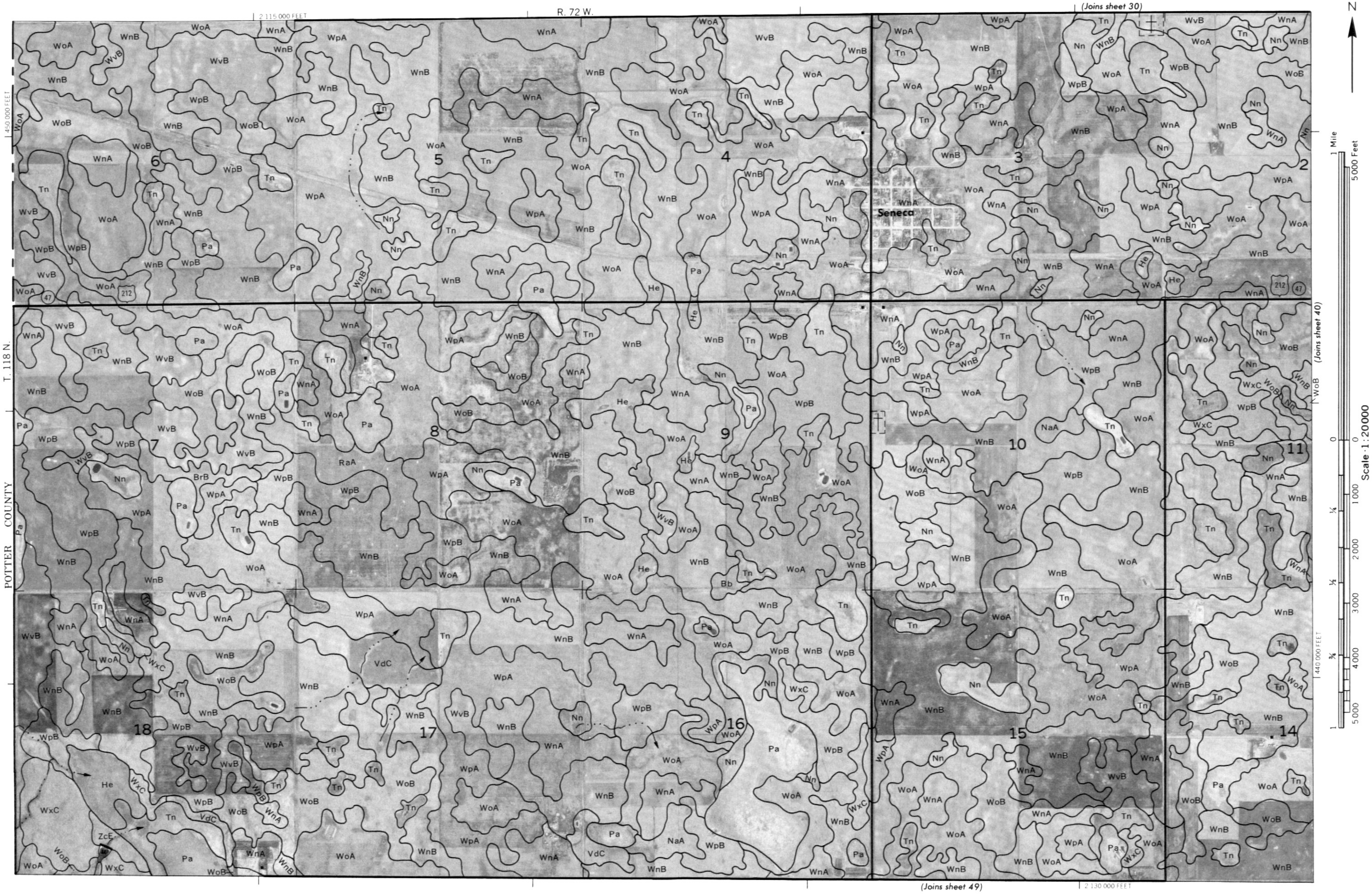
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(Joins sheet 49)
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T. 118 N.
POTTER COUNTY
2 115 000 FEET
2 130 000 FEET
450 000 FEET
440 000 FEET
Seneca
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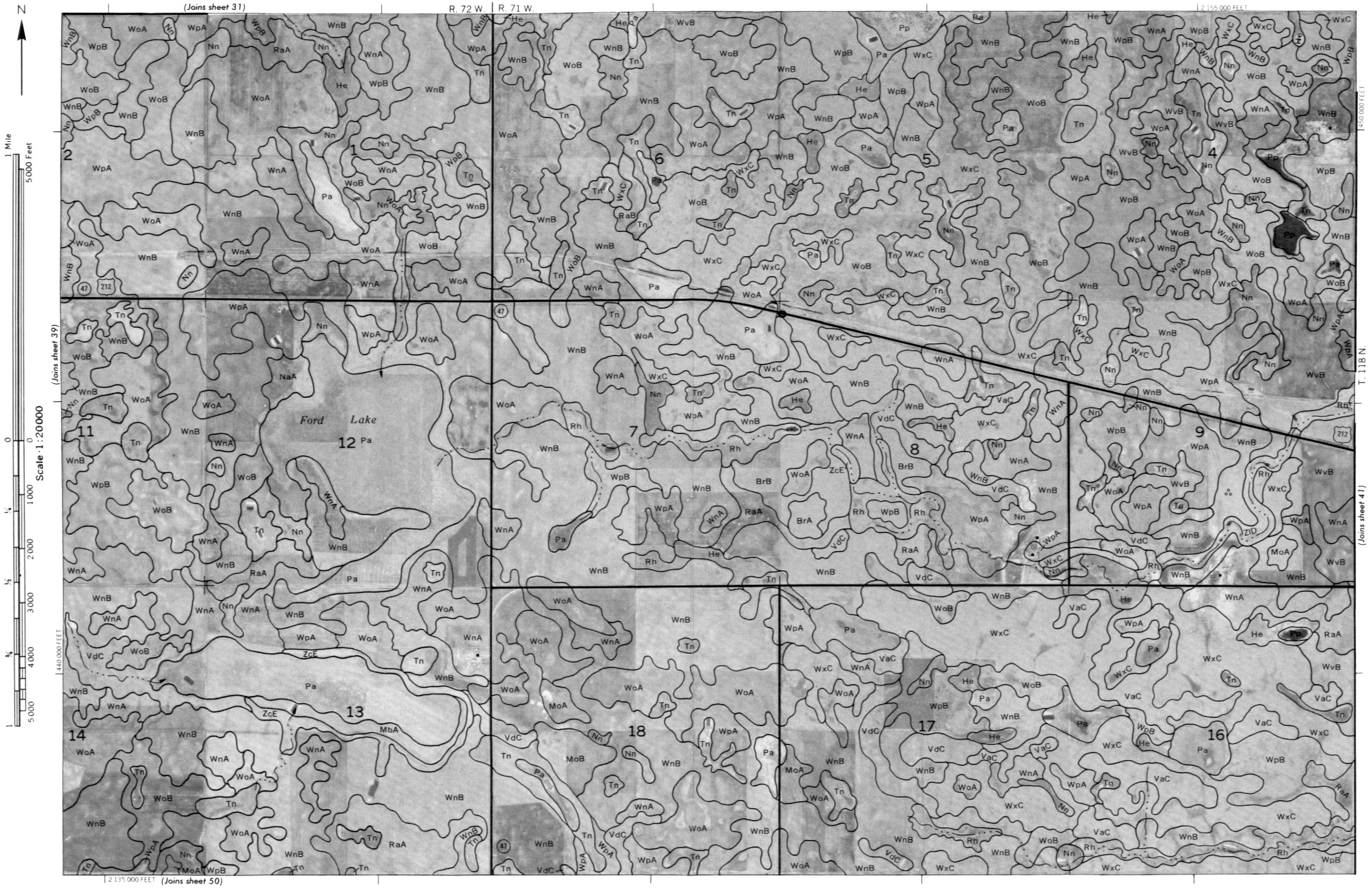

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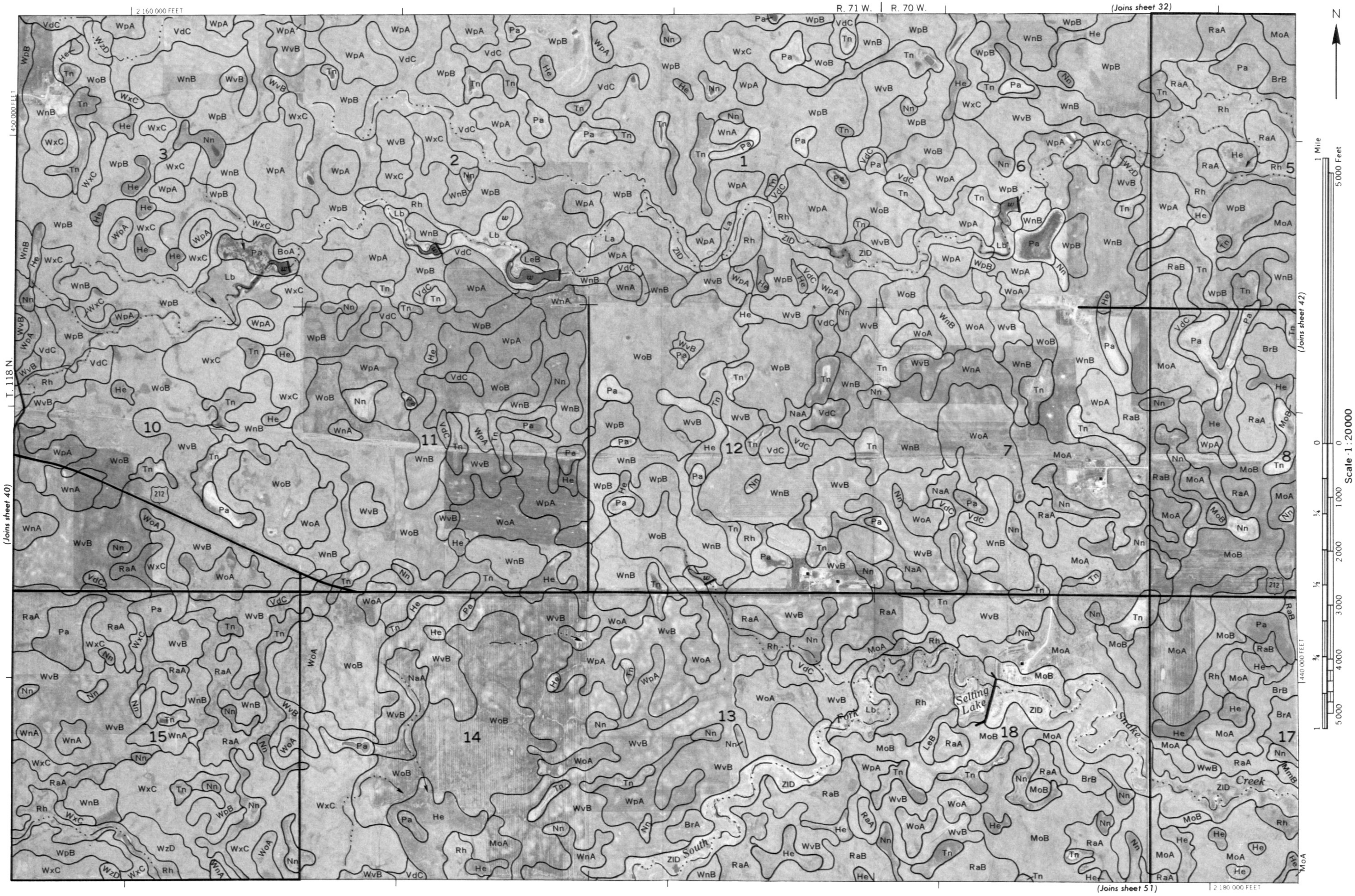

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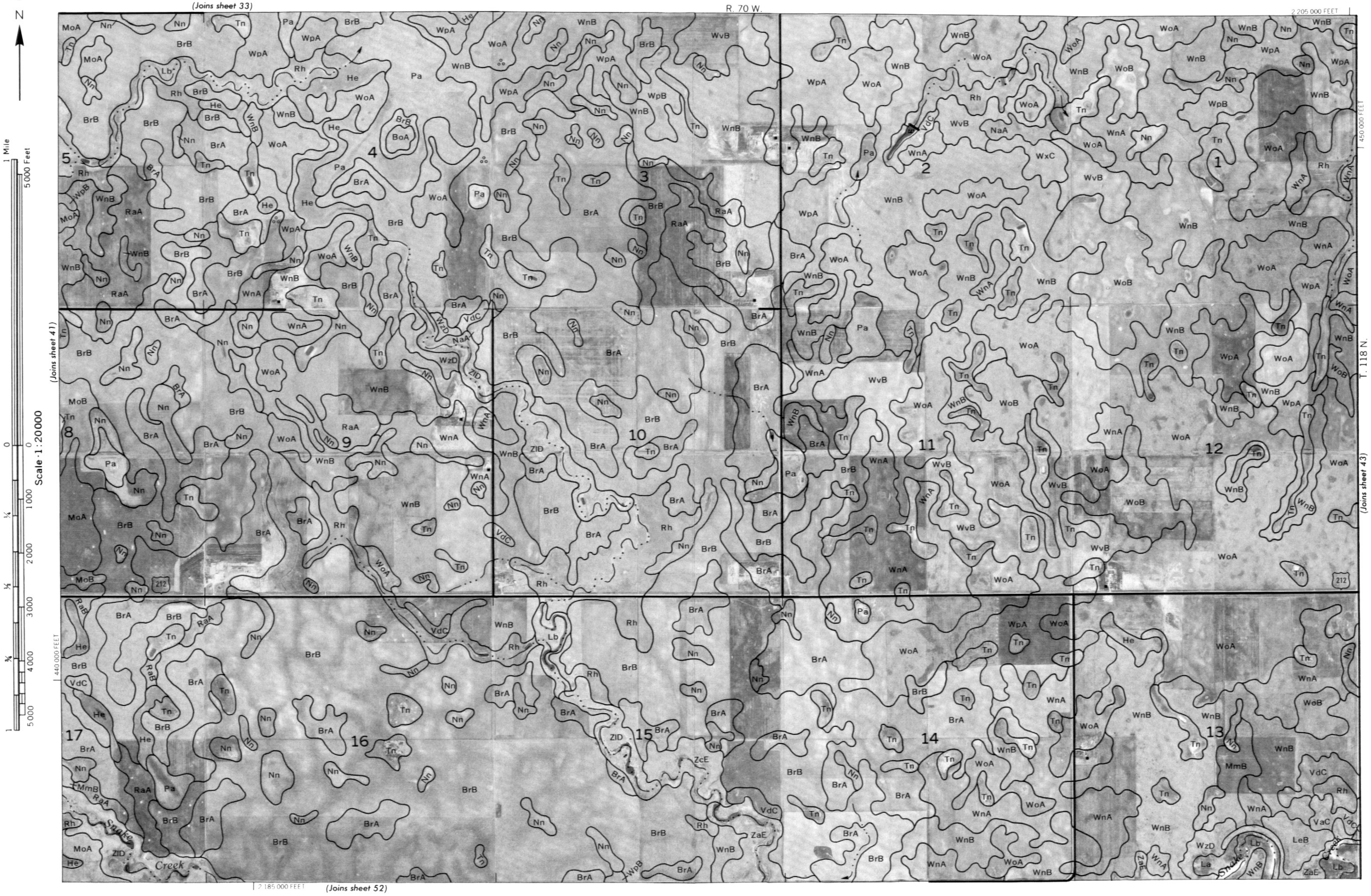

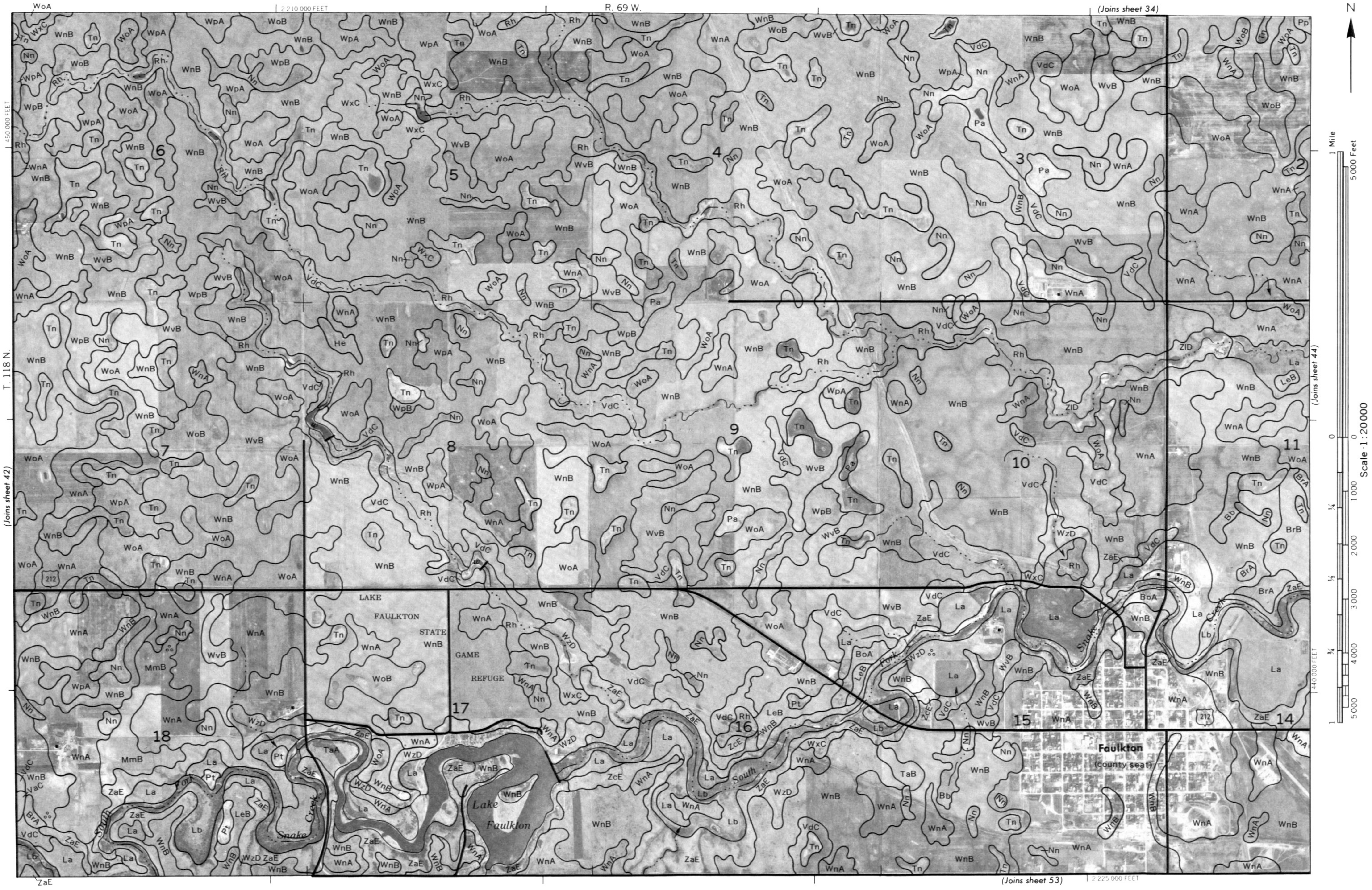
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R. 69 W.
T. 118 N.
(Joins sheet 34)
(Joins sheet 42)
(Joins sheet 44)
(Joins sheet 53)
2 210 000 FEET
2 225 000 FEET
450 000 FEET
440 000 FEET
1 Mile
5000 Feet
Scale 1:20000
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3000
4000
5000
¼
½
¾
1
LAKE FAULKTON STATE GAME REFUGE
Lake Faulkton
Faulkton
(county seat)
South Fork Snake Creek
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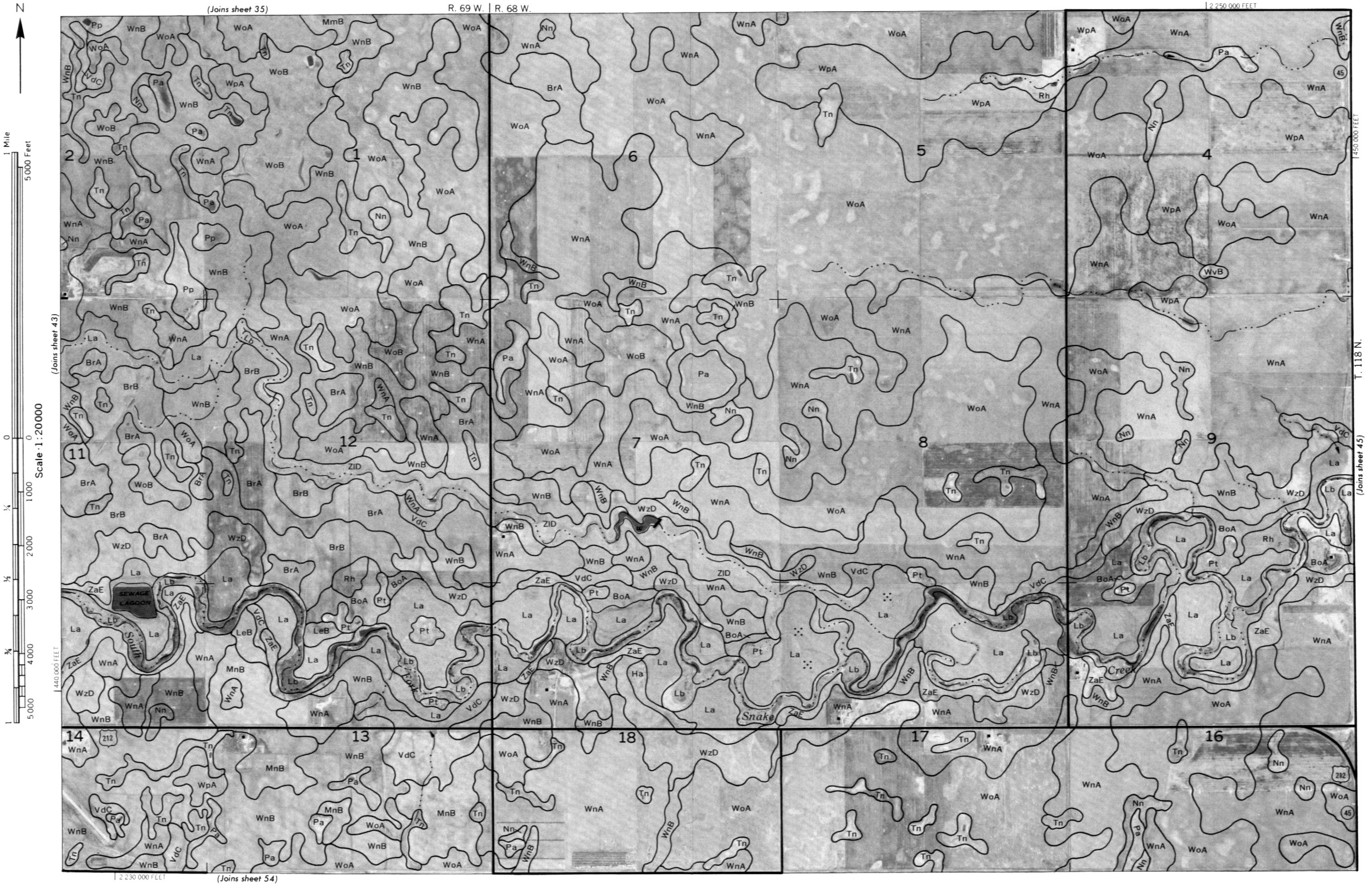
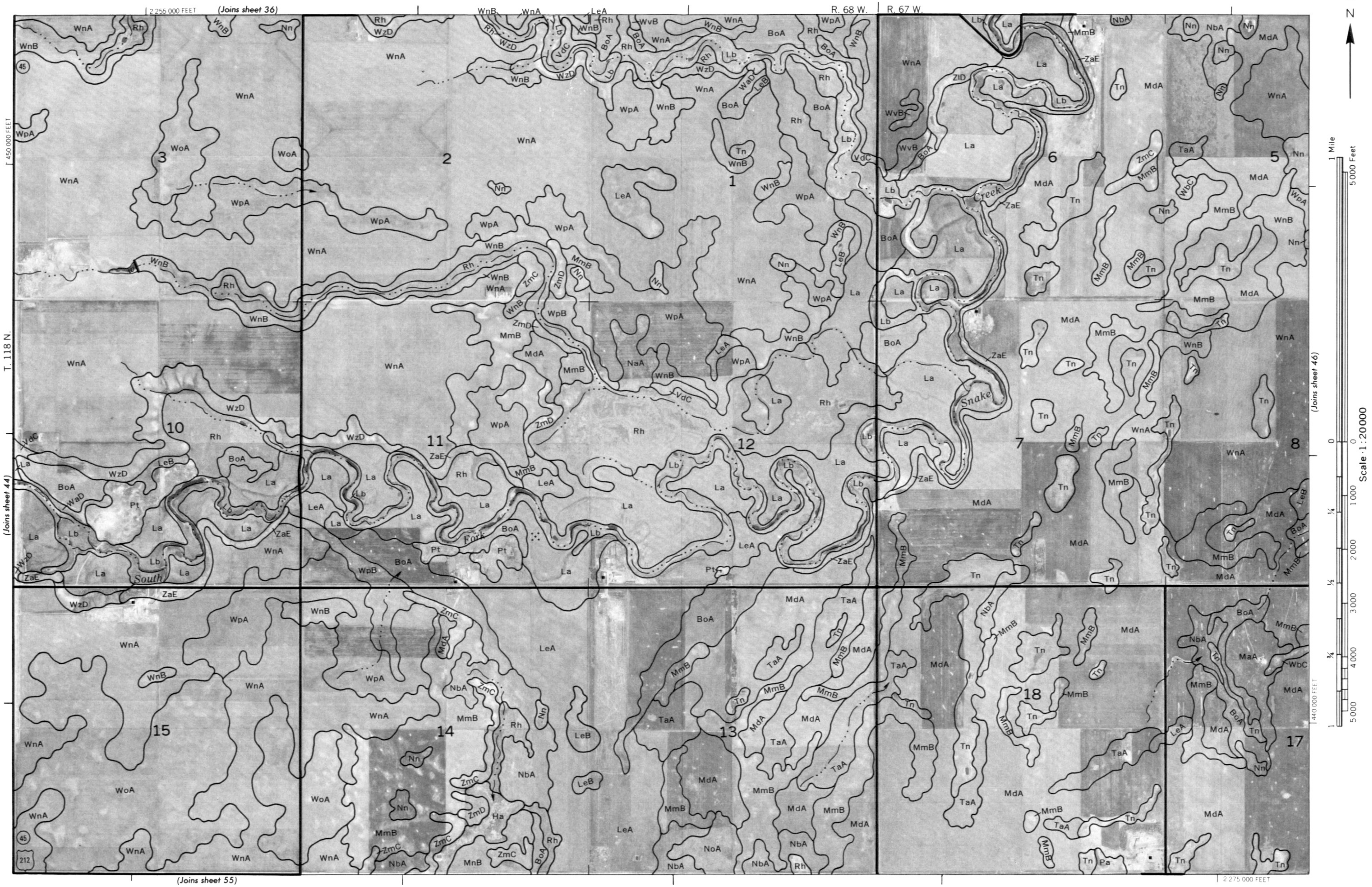
18

FAULK COUNTY, SOUTH DAKOTA — SHEET NUMBER 44

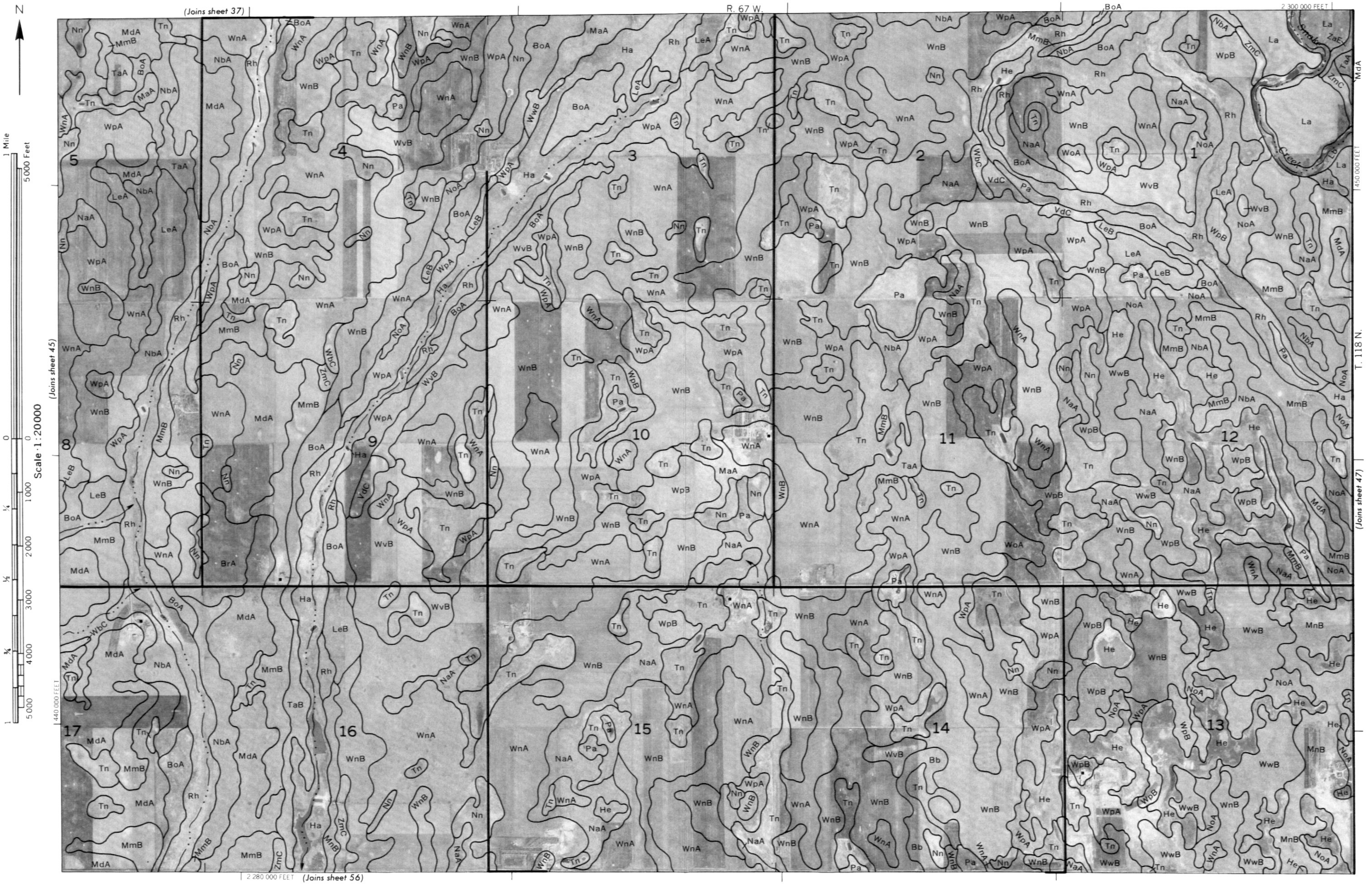


FAULK COUNTY, SOUTH DAKOTA — SHEET NUMBER 45

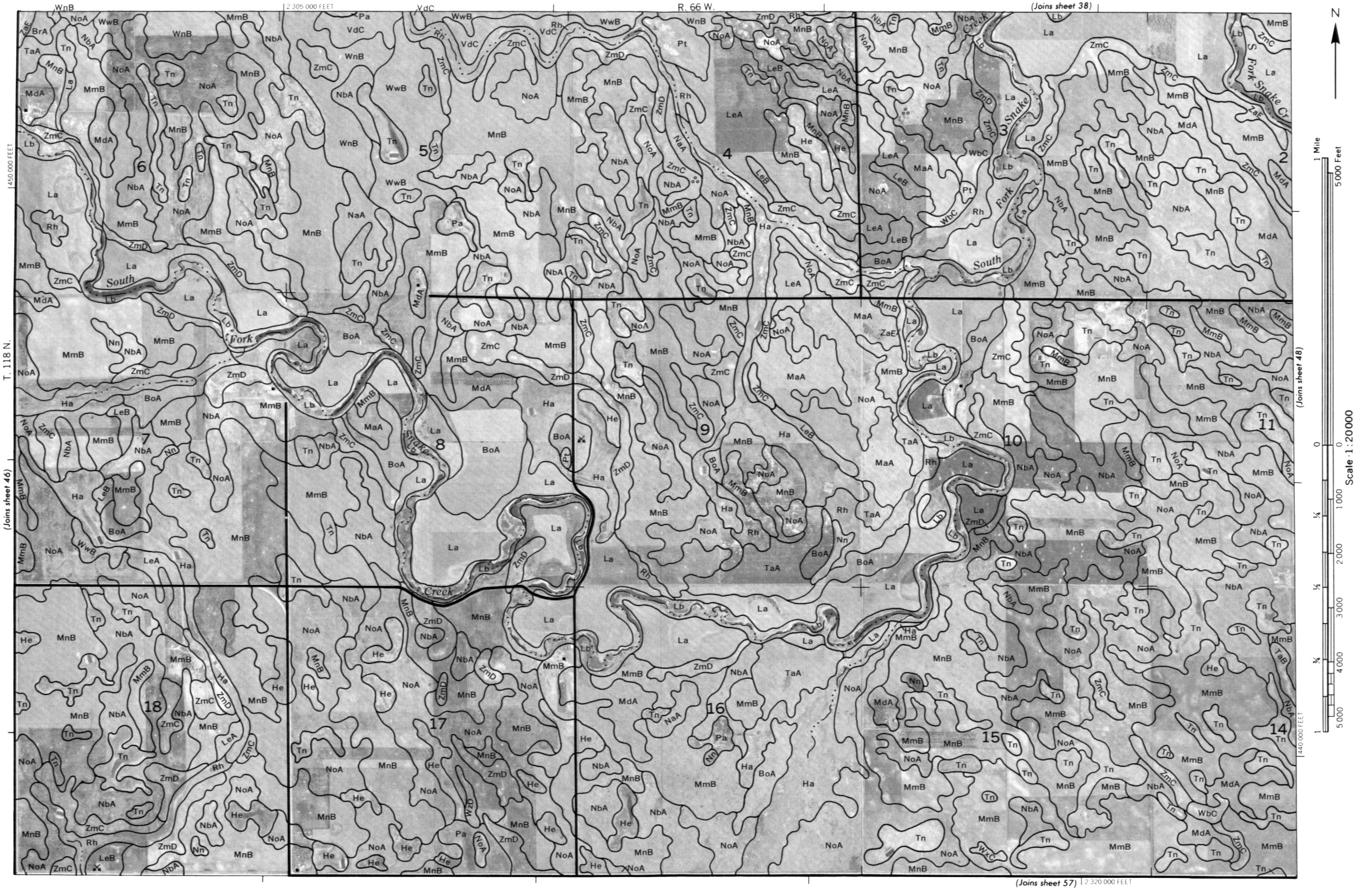


(46)

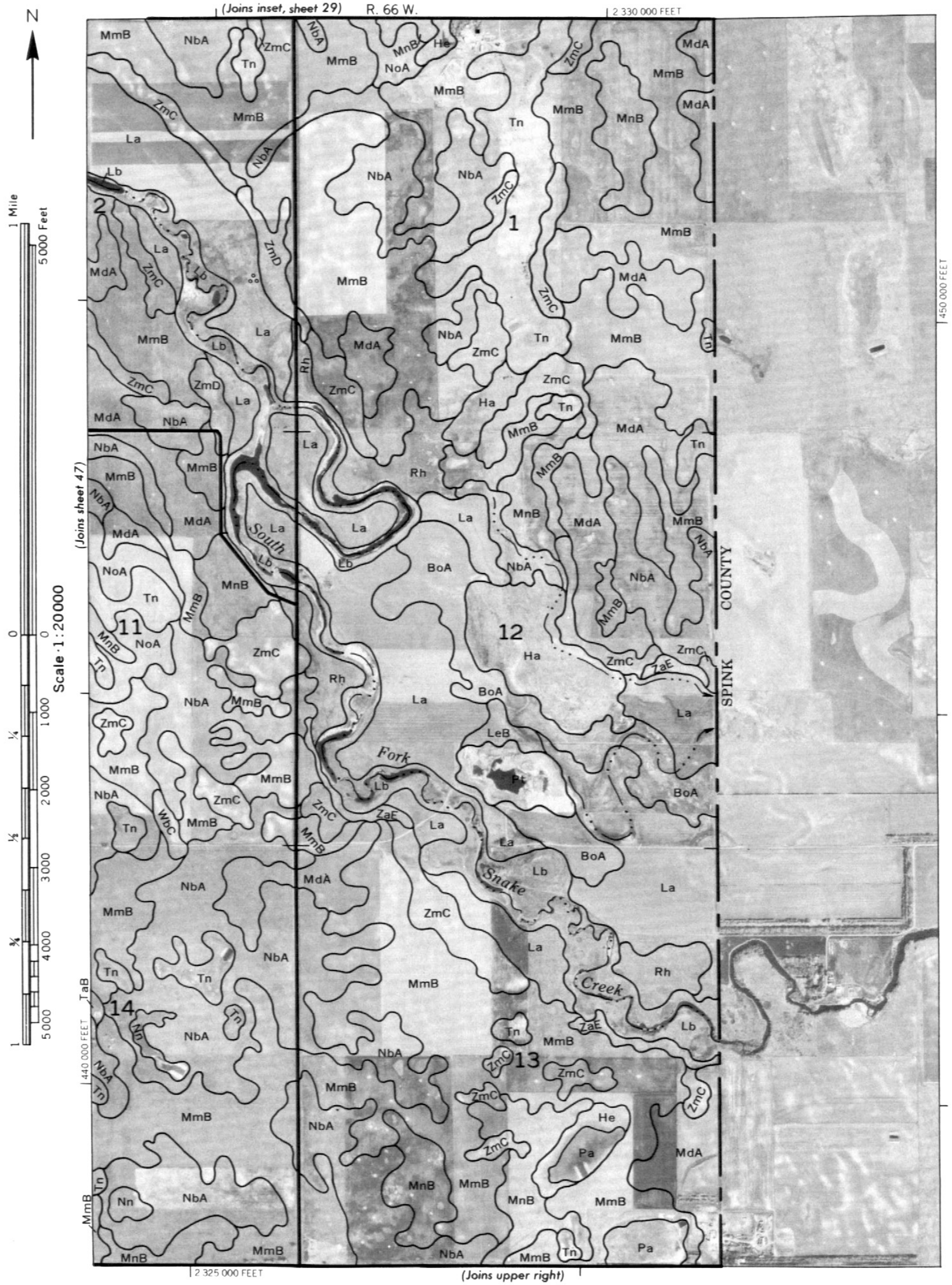
FAULK COUNTY, SOUTH DAKOTA — SHEET NUMBER 46

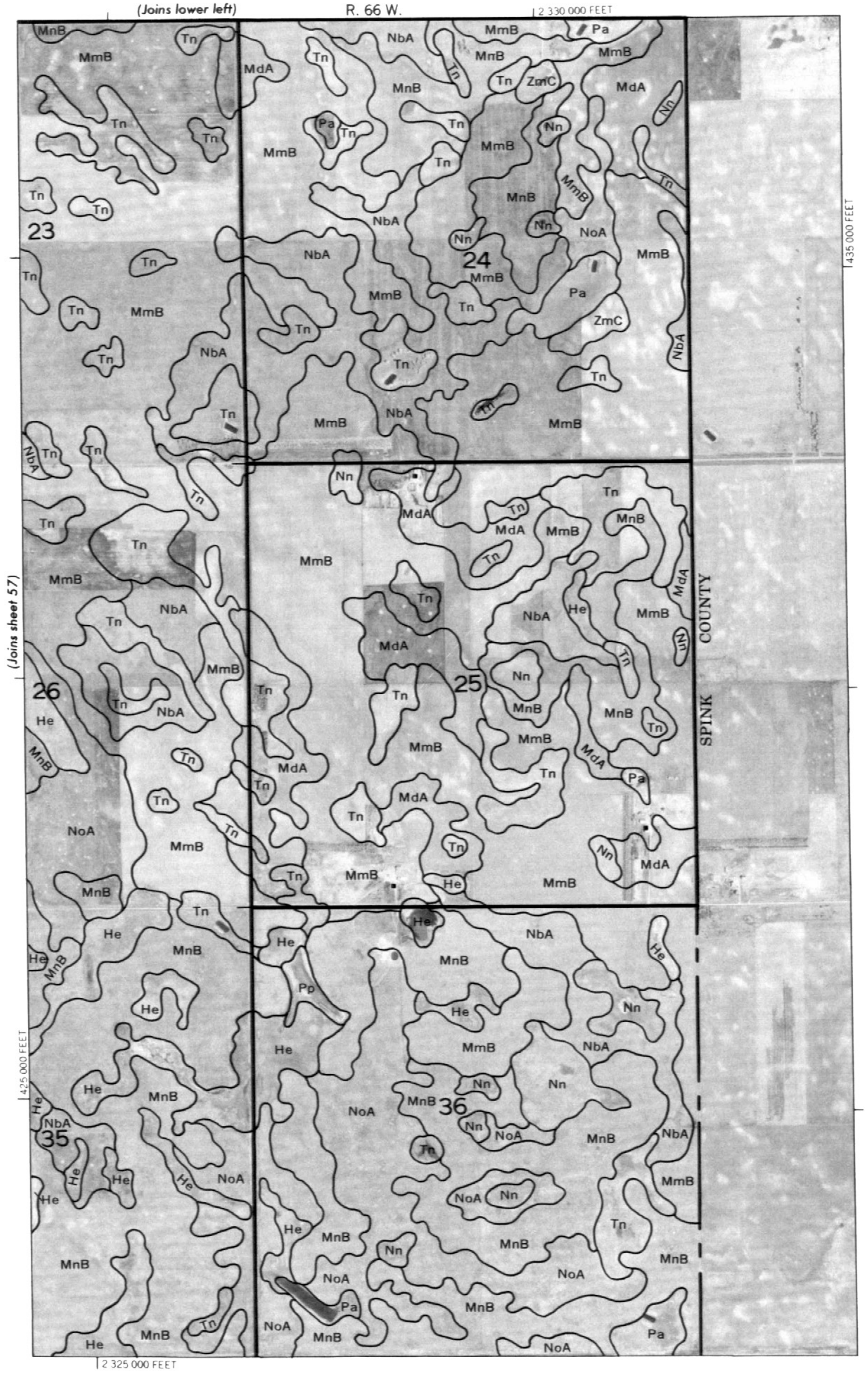


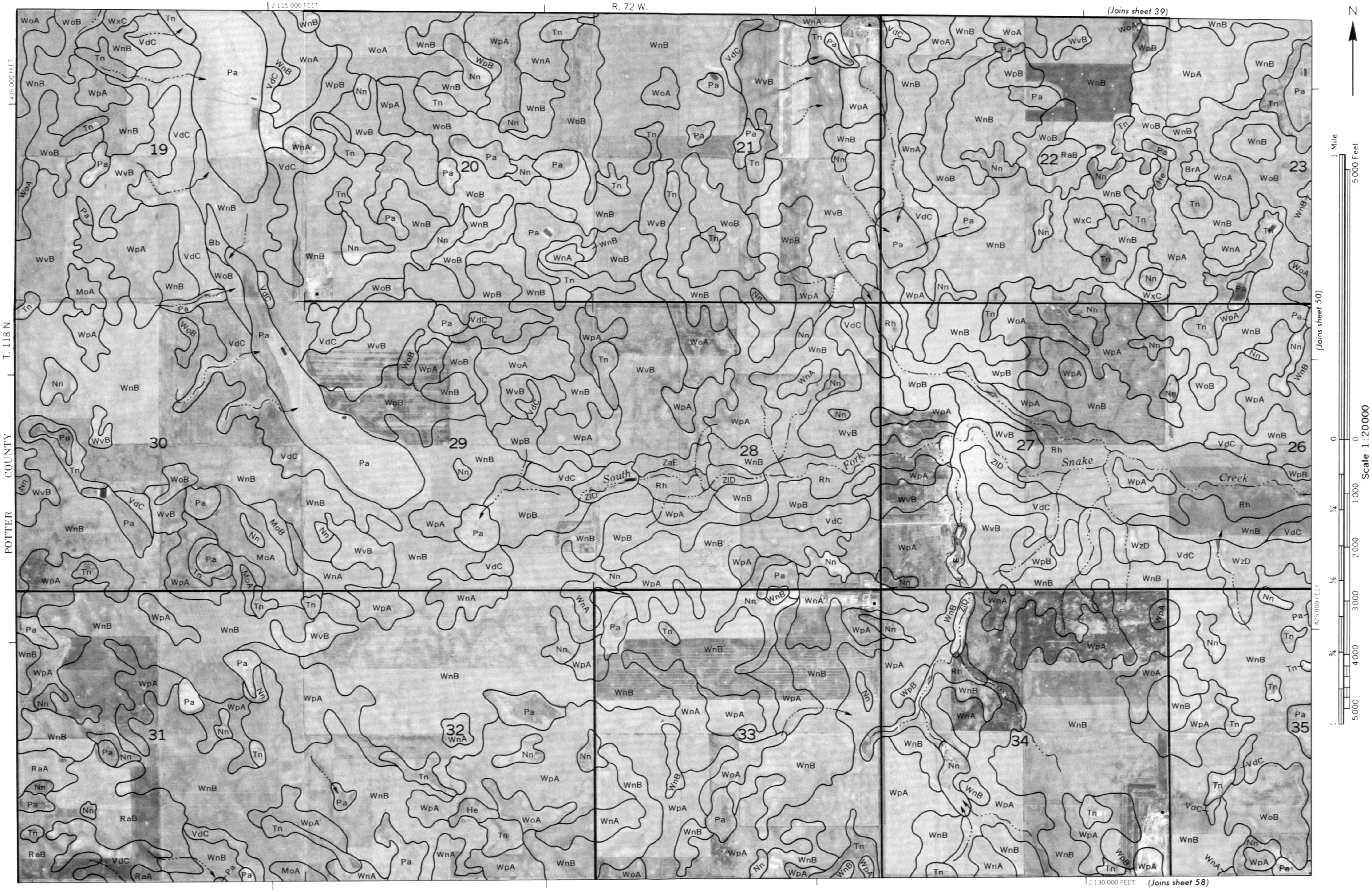
FAULK COUNTY, SOUTH DAKOTA — SHEET NUMBER 47

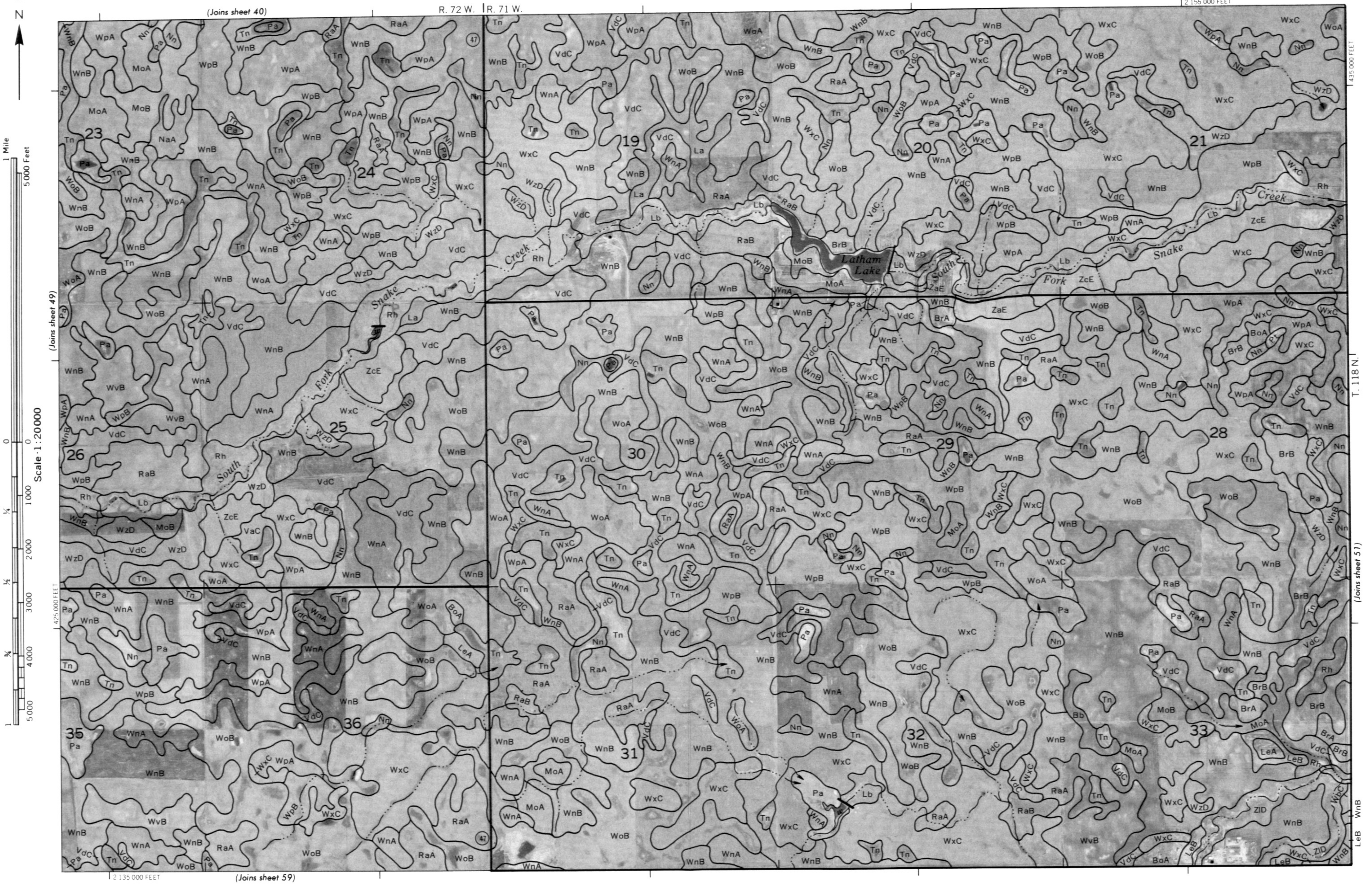


FAULK COUNTY, SOUTH DAKOTA — SHEET NUMBER 48

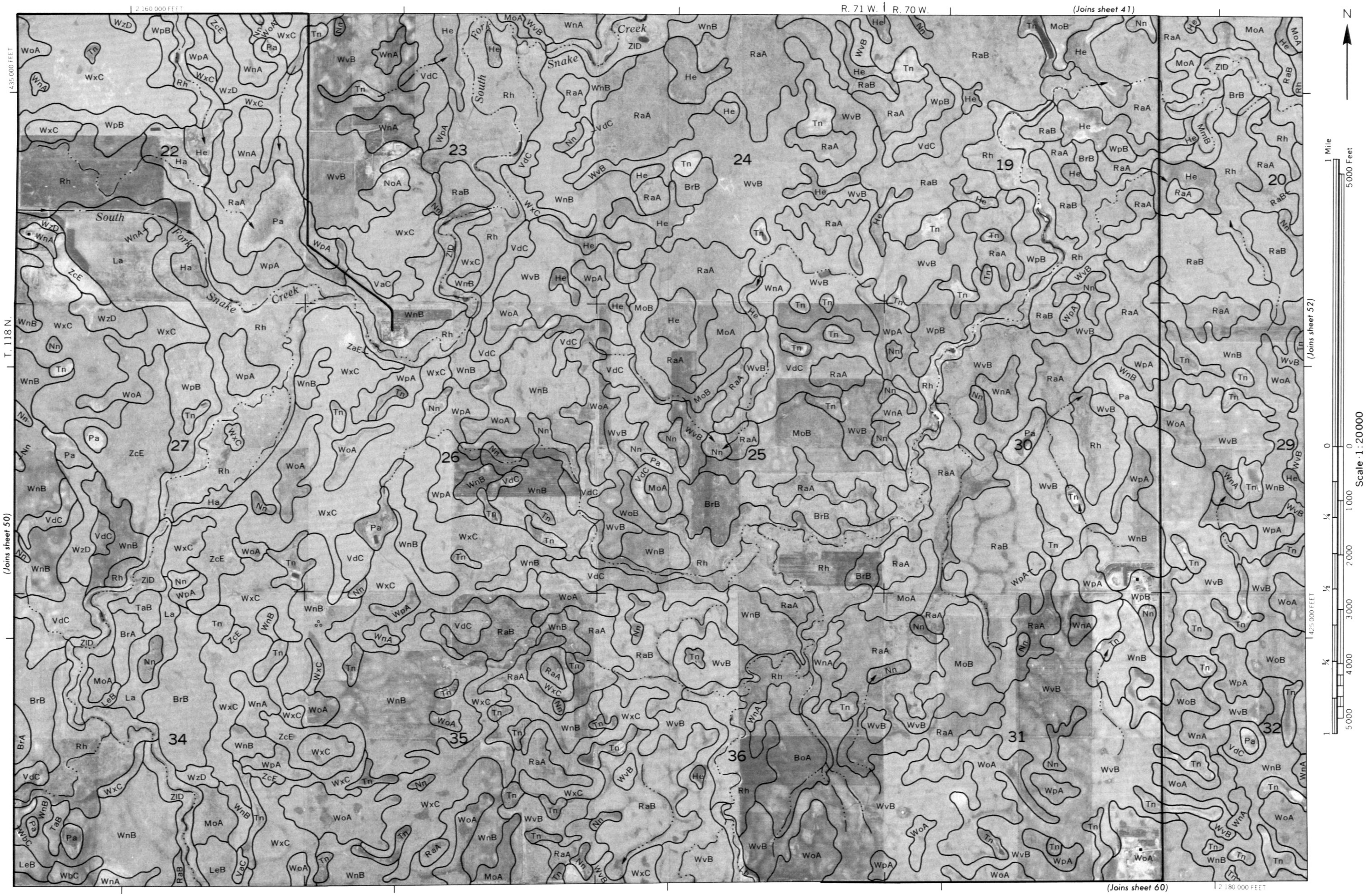




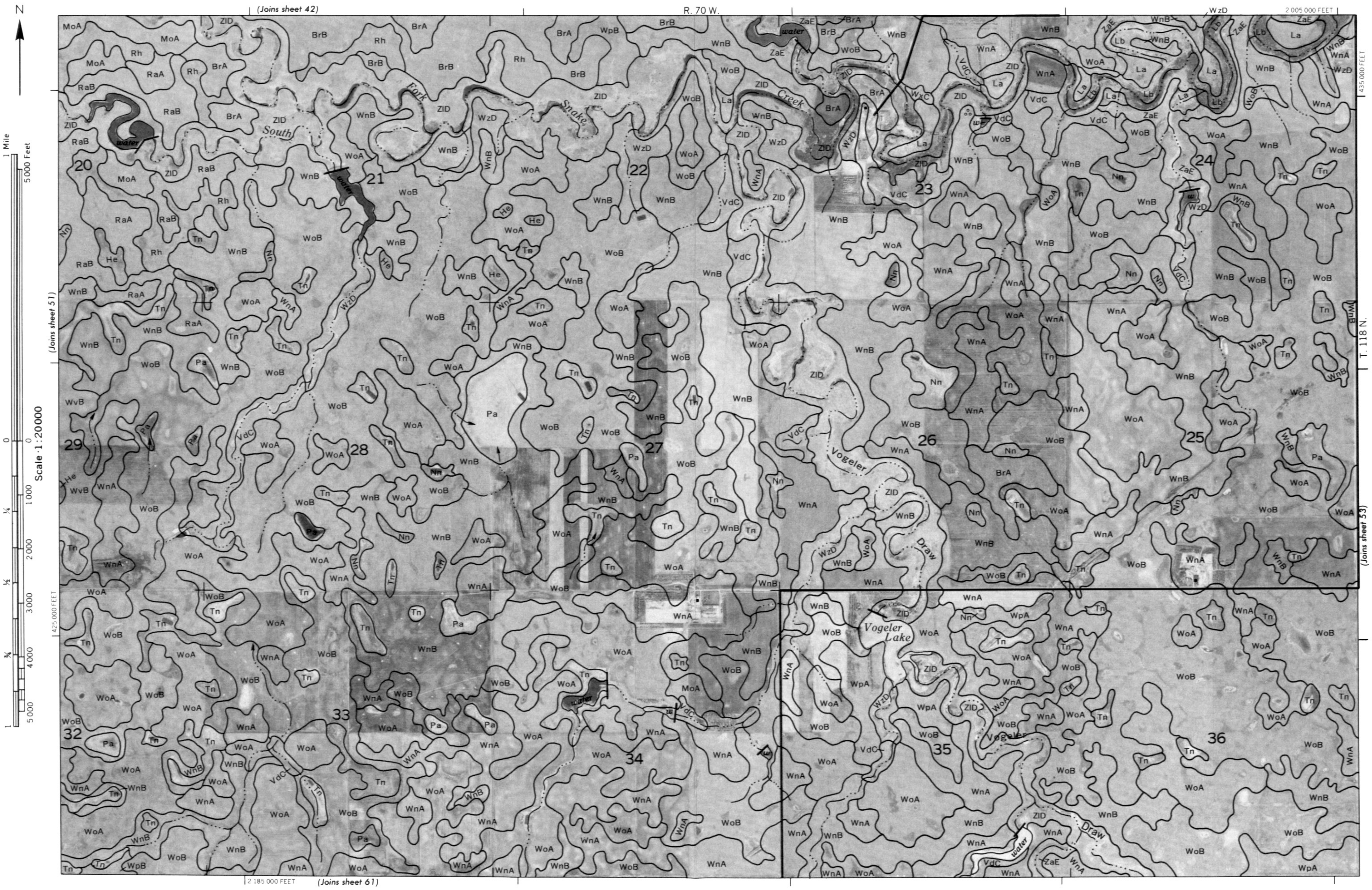

2 115 000 FEET
R. 72 W.
(Joins sheet 39)
435 000 FEET
T. 118 N.
POTTER COUNTY
(Joins sheet 50)
425 000 FEET
2 130 000 FEET
(Joins sheet 58)
N
19
20
21
22
23
30
29
28
27
26
31
32
33
34
35
South Fork
Snake Creek
Scale 1:20000
1 Mile
0
¼
½
¾
1
5000 Feet
0
1000
2000
3000
4000
5000


N
(Joins sheet 40)
R. 72 W.
R. 71 W.
2 155 000 FEET
435 000 FEET
(Joins sheet 49)
(Joins sheet 51)
T. 118 N.
425 000 FEET
2 135 000 FEET
(Joins sheet 59)
Scale 1:20000
1 Mile
5000 Feet
0
1000
2000
3000
4000
5000
¼
½
¾
1
19
20
21
23
24
25
26
28
29
30
31
32
33
35
36
Latham Lake
Snake Creek
South Fork
47

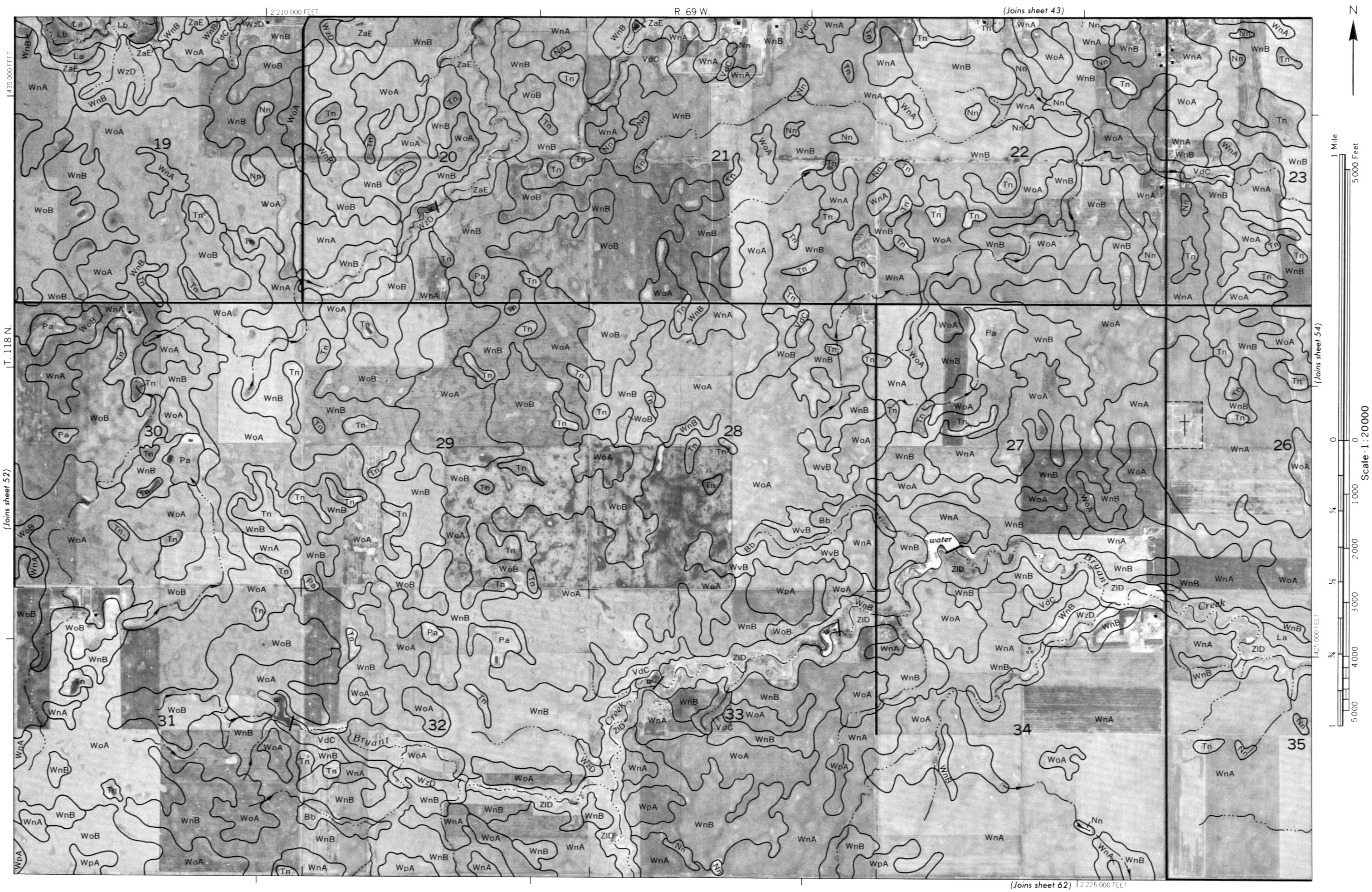
FAULK COUNTY, SOUTH DAKOTA — SHEET NUMBER 51



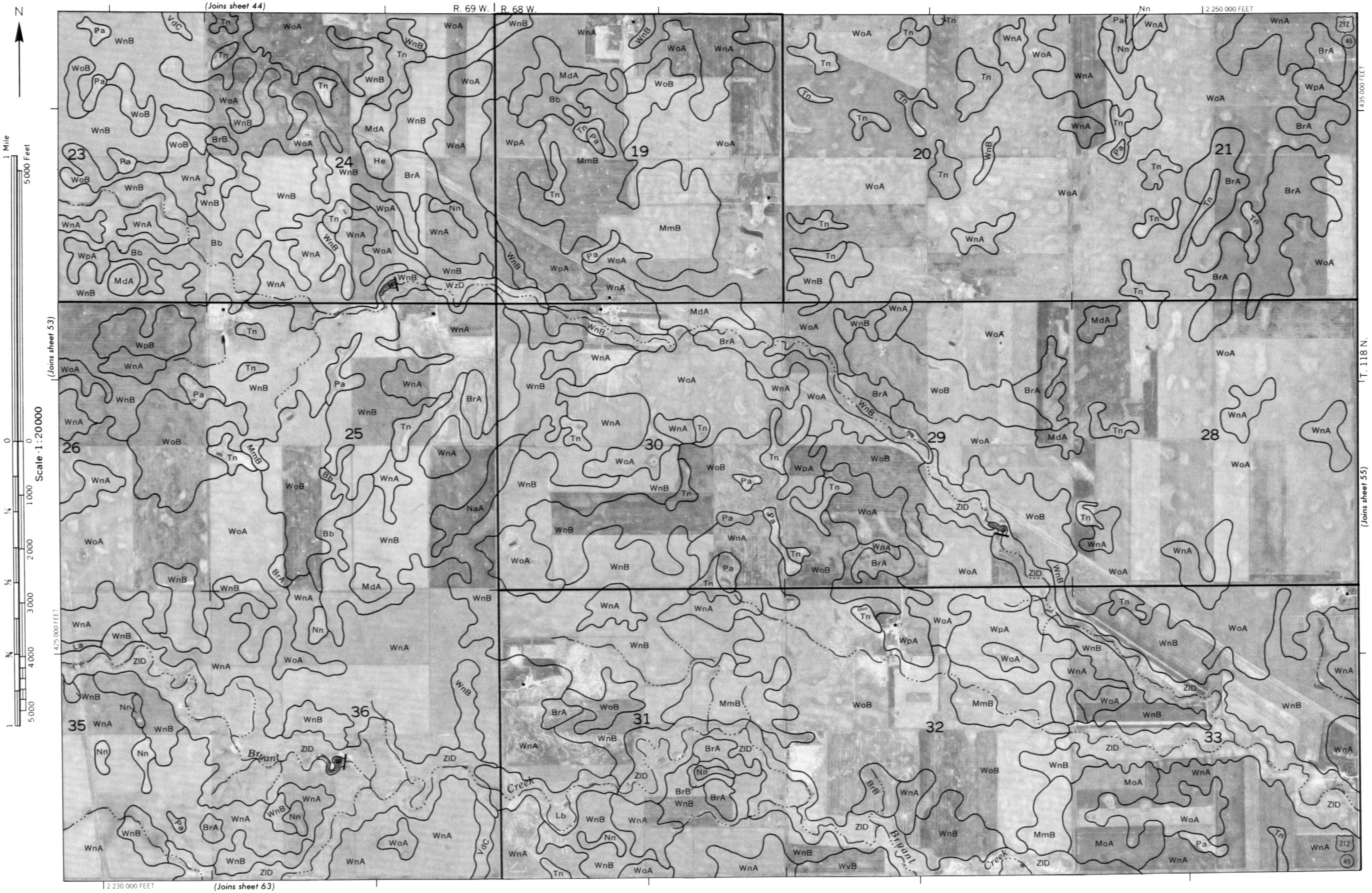
FAULK COUNTY, SOUTH DAKOTA — SHEET NUMBER 52

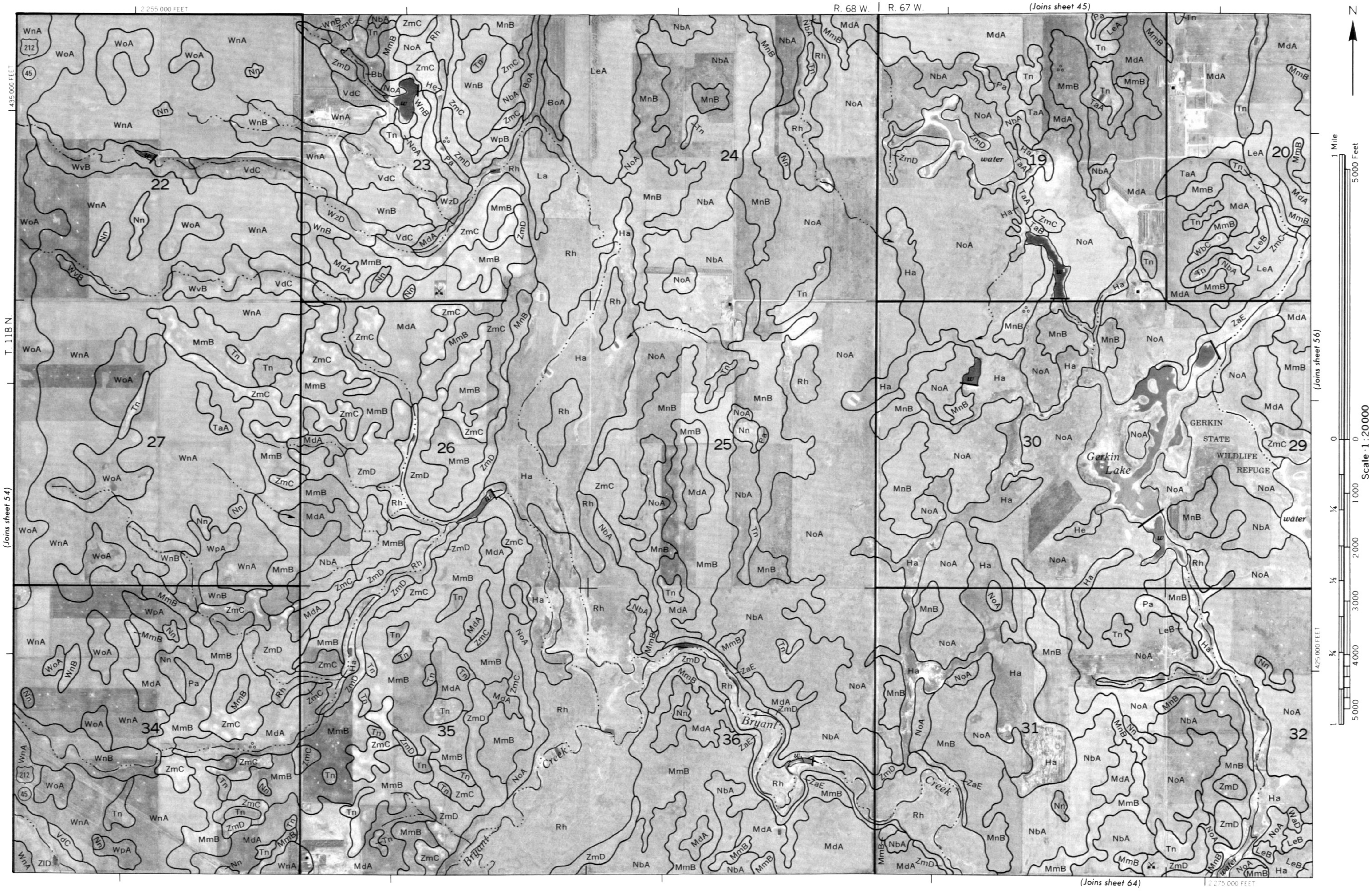


FAULK COUNTY, SOUTH DAKOTA — SHEET NUMBER 53

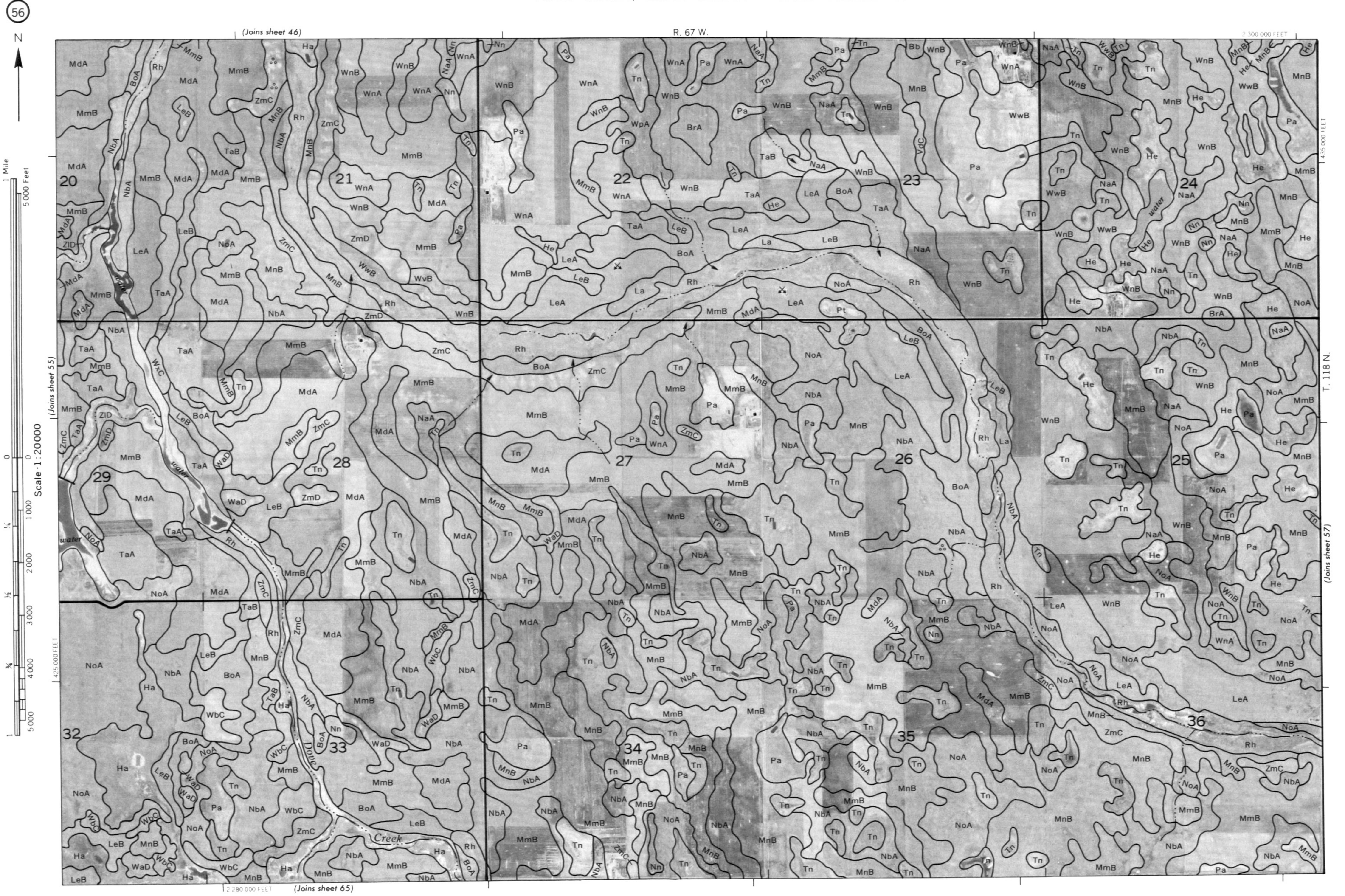


FAULK COUNTY, SOUTH DAKOTA — SHEET NUMBER 54

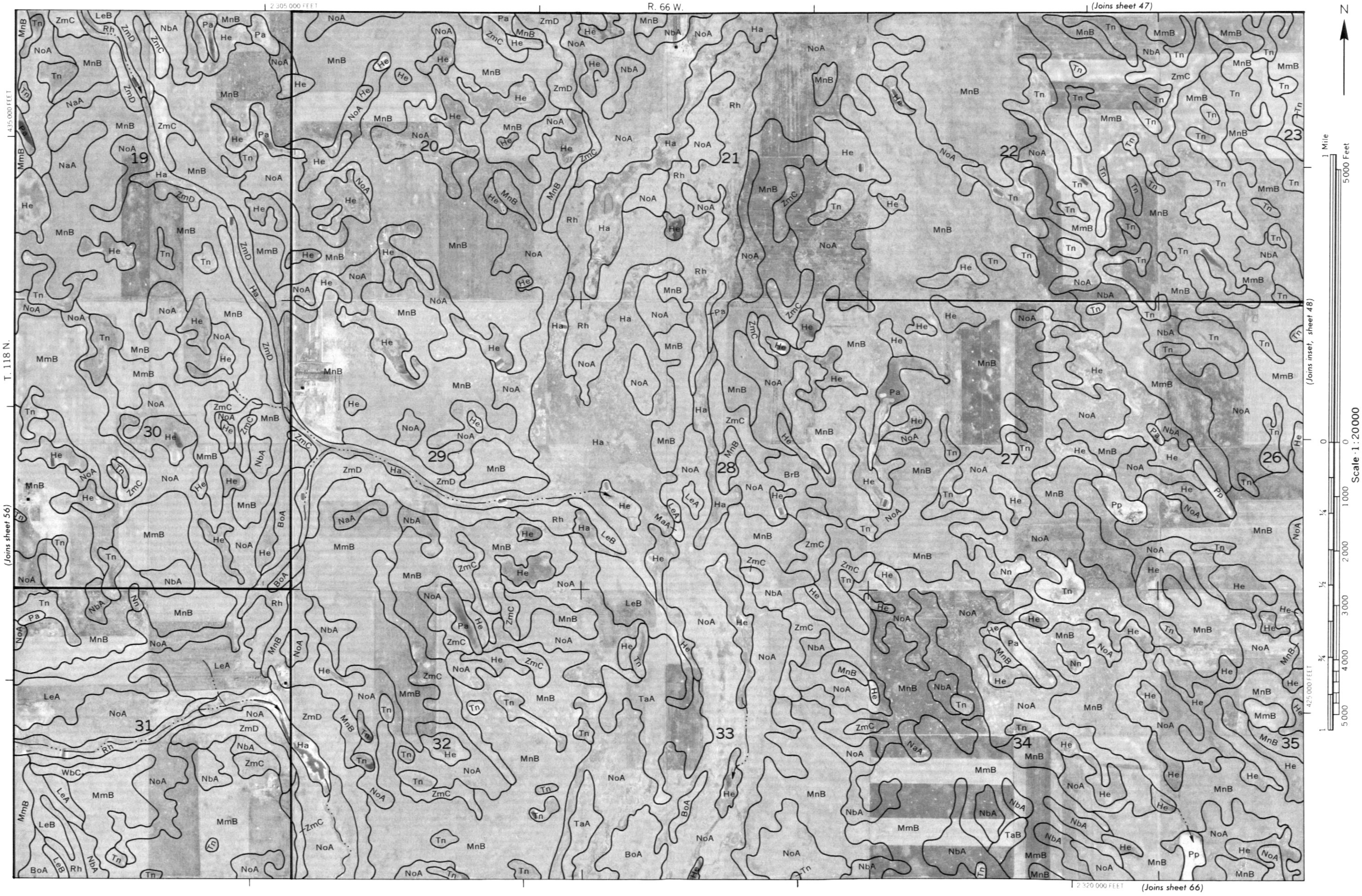



2 255 000 FEET
R. 68 W.
R. 67 W.
(Joins sheet 45)
(Joins sheet 56)
(Joins sheet 64)
(Joins sheet 54)
435 000 FEET
425 000 FEET
2 275 000 FEET
T. 118 N.
N
212
45
19
20
22
23
24
25
26
27
29
30
31
32
34
35
36
Gerkin Lake
GERKIN STATE WILDLIFE REFUGE
Bryant Creek
water
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
¼
½
¾
1

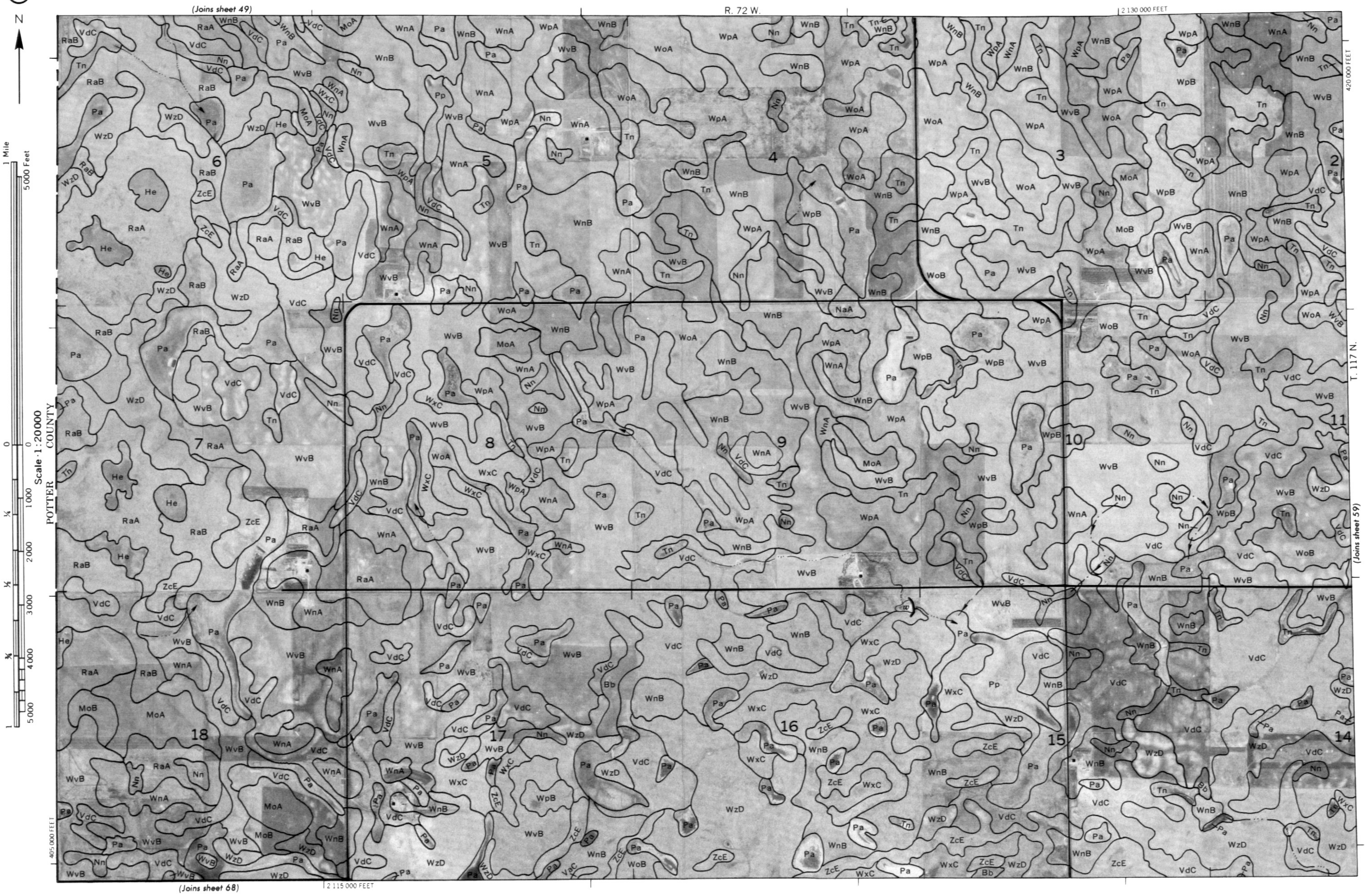
FAULK COUNTY, SOUTH DAKOTA — SHEET NUMBER 56



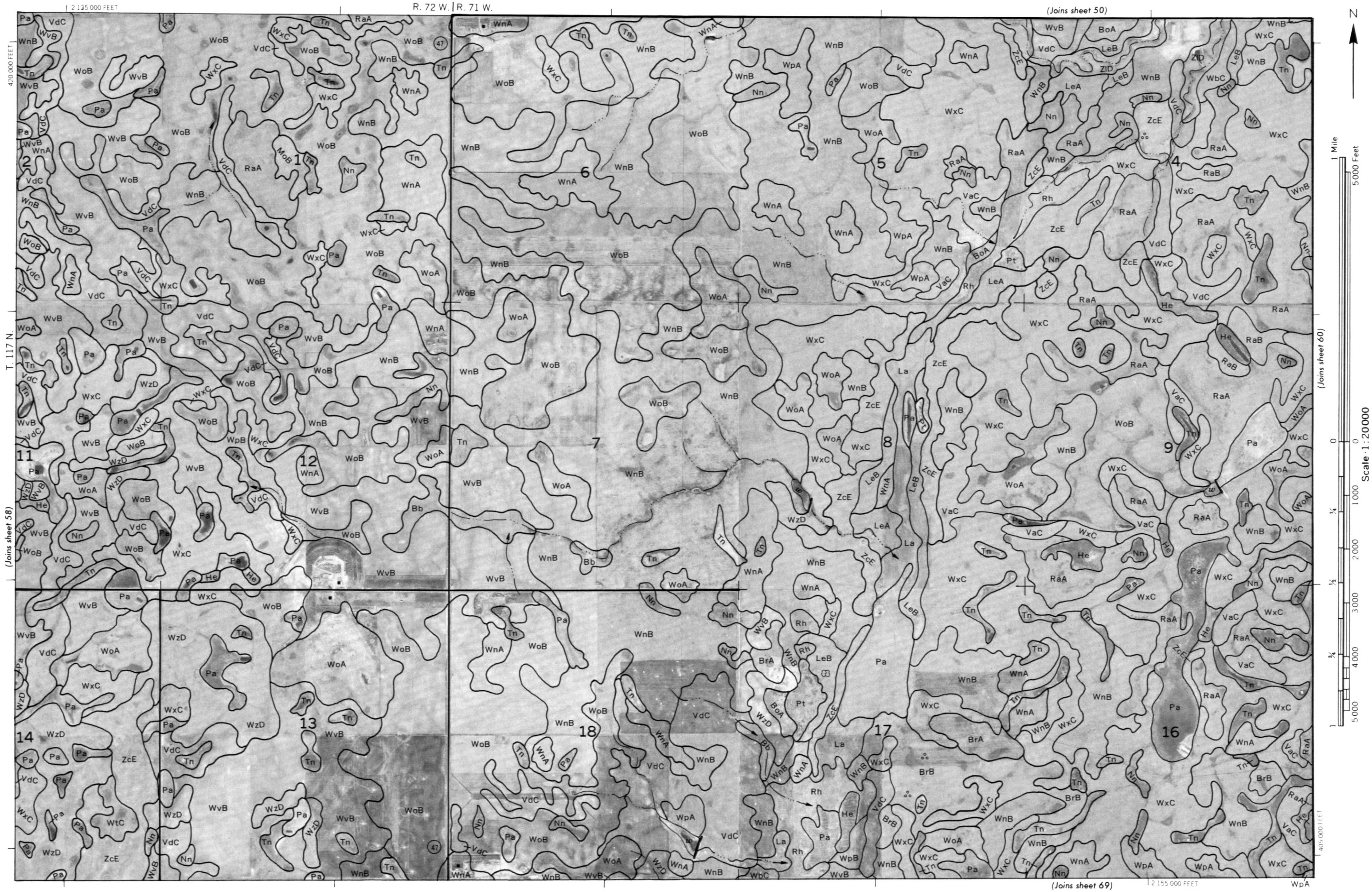
FAULK COUNTY, SOUTH DAKOTA — SHEET NUMBER 57



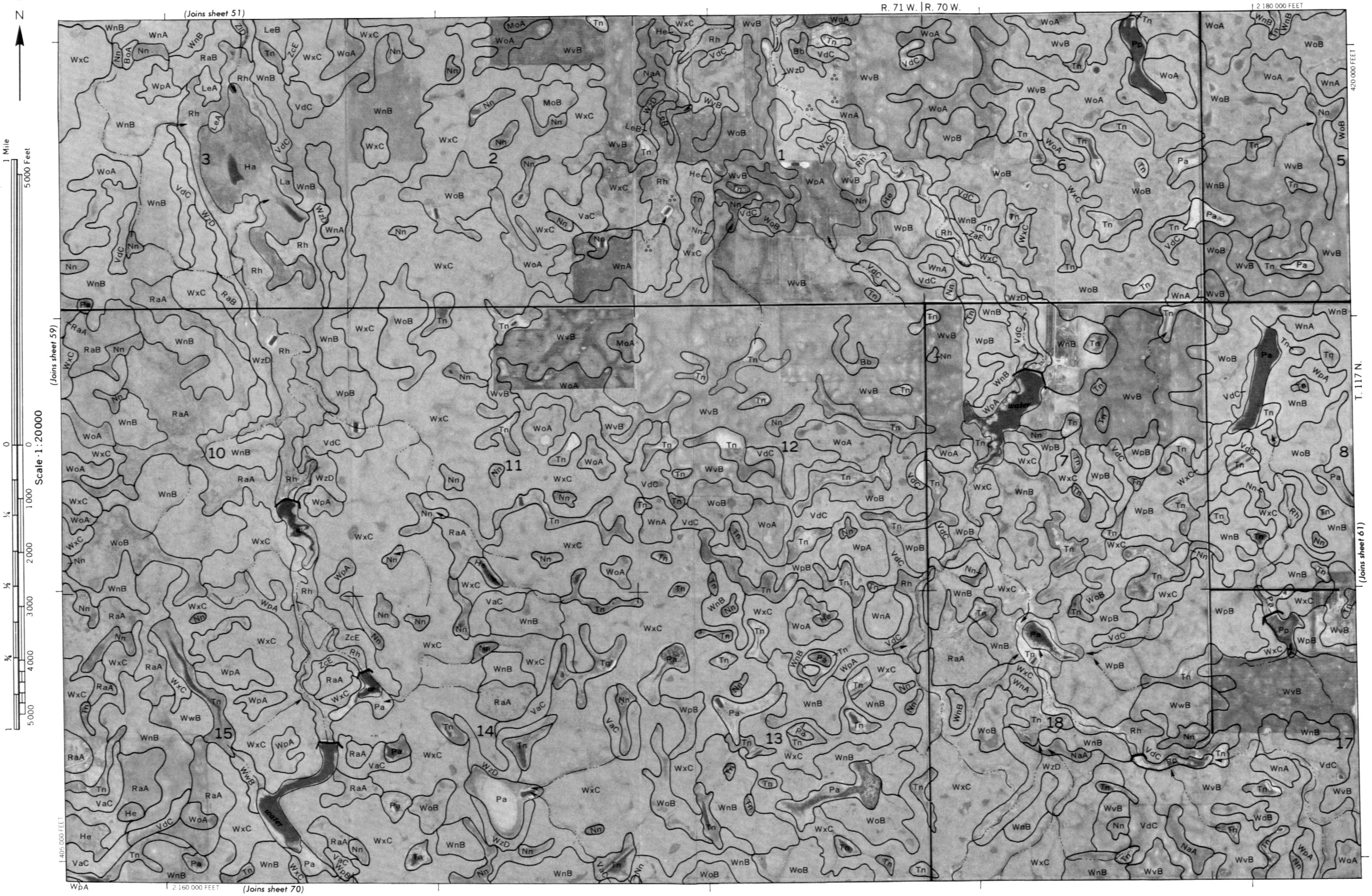
FAULK COUNTY, SOUTH DAKOTA — SHEET NUMBER 58



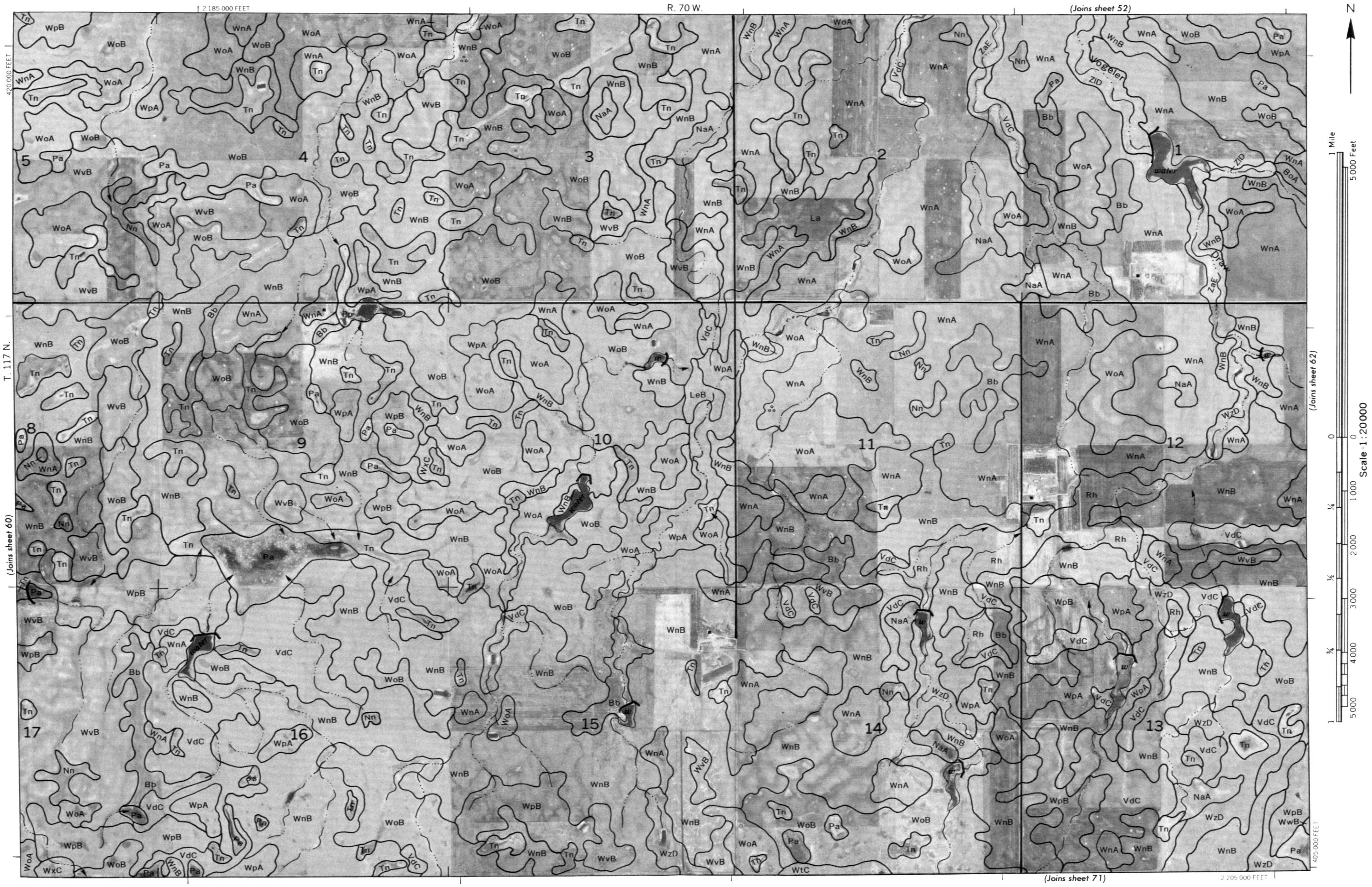
FAULK COUNTY, SOUTH DAKOTA — SHEET NUMBER 59



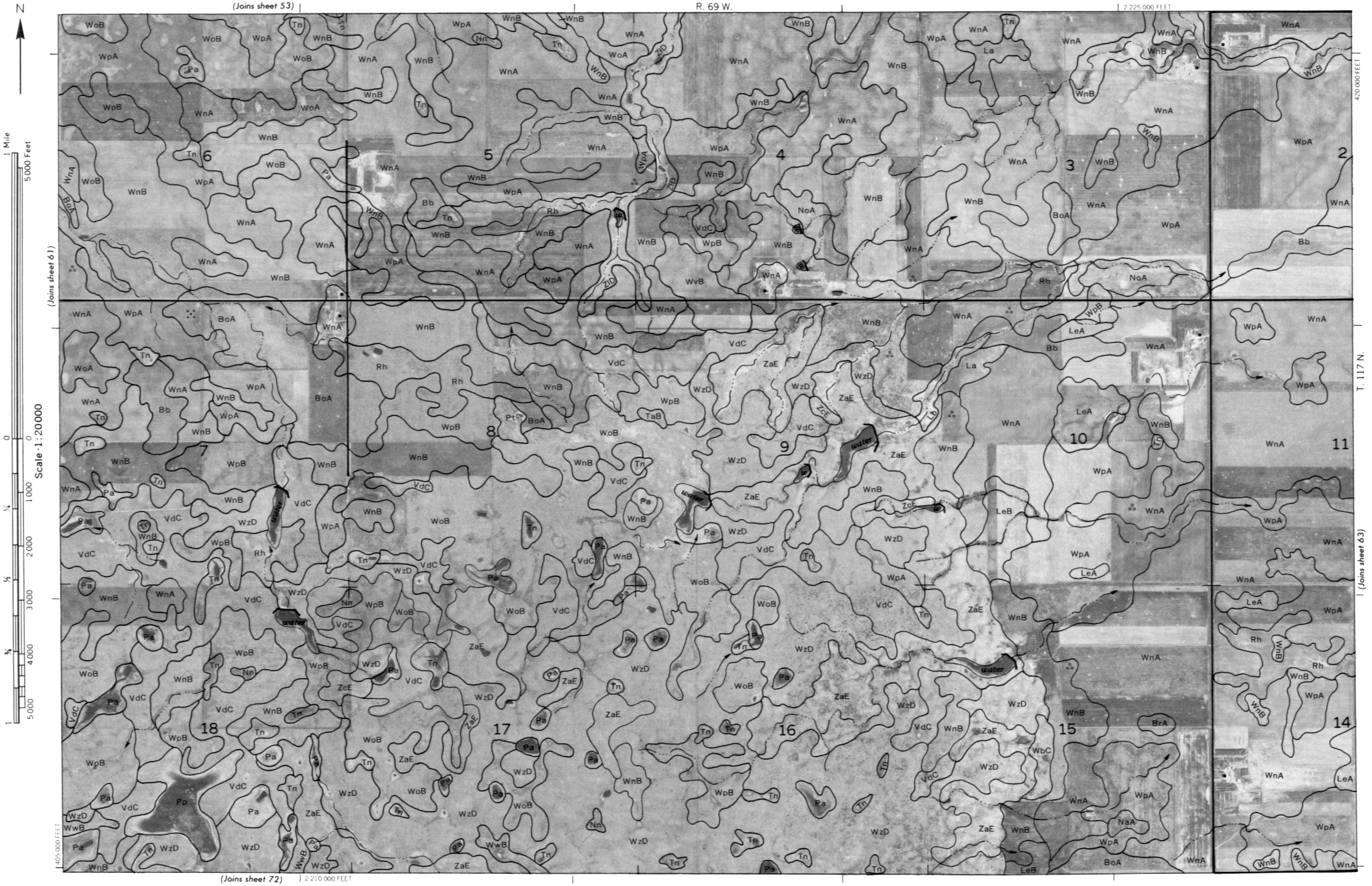
FAULK COUNTY, SOUTH DAKOTA — SHEET NUMBER 60



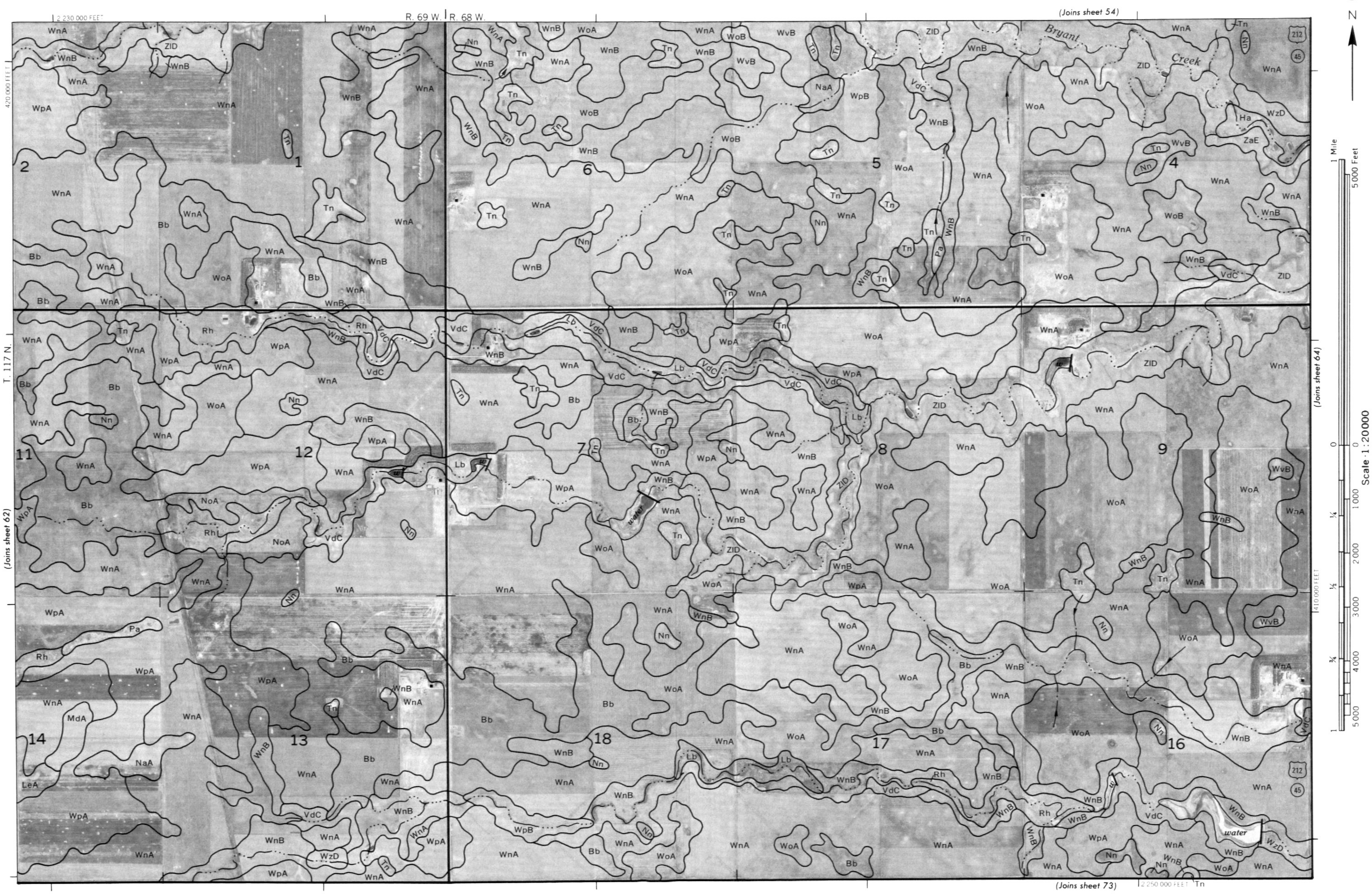
FAULK COUNTY, SOUTH DAKOTA — SHEET NUMBER 61



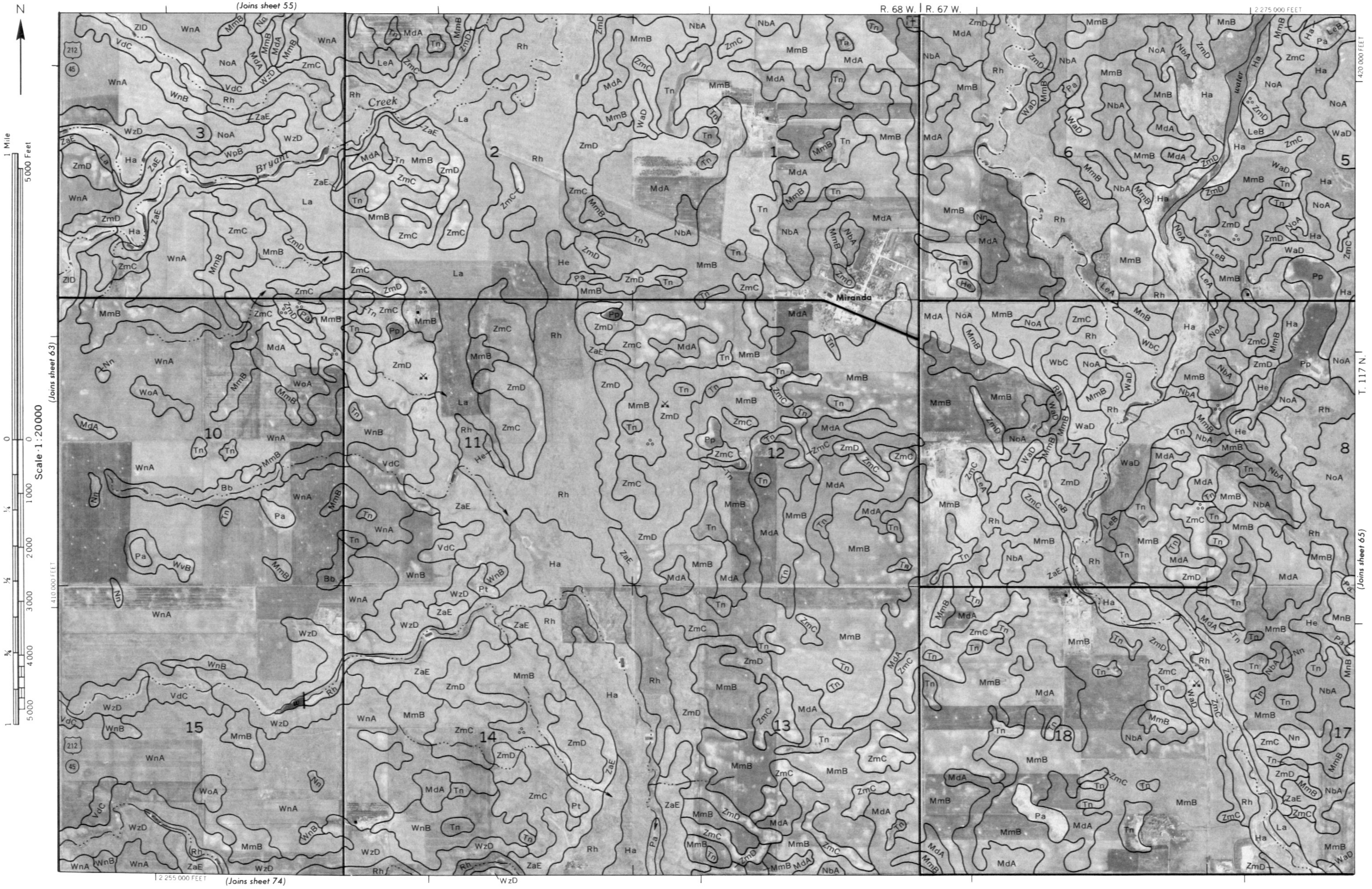
FAULK COUNTY, SOUTH DAKOTA — SHEET NUMBER 62

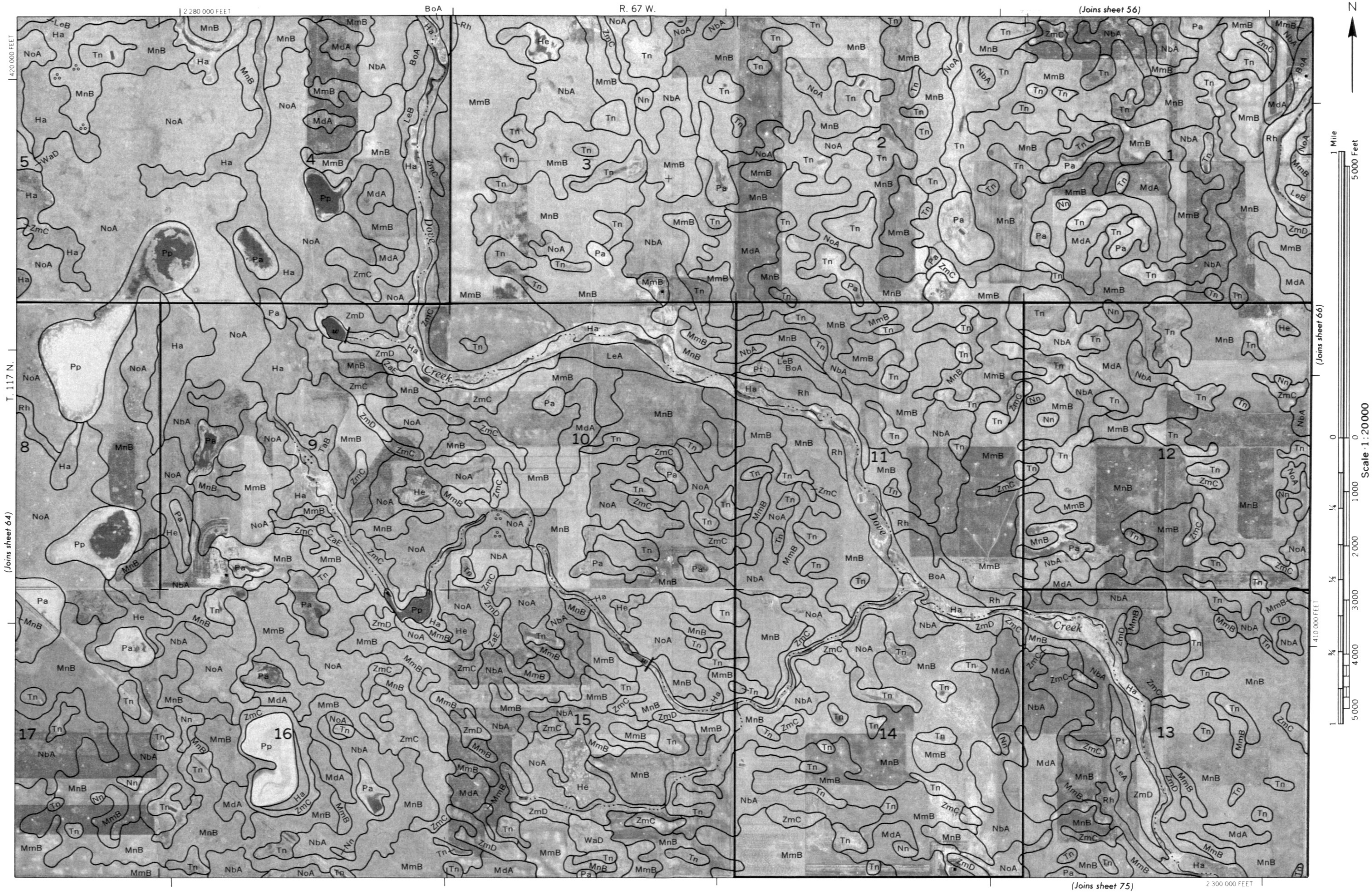


FAULK COUNTY, SOUTH DAKOTA — SHEET NUMBER 63



FAULK COUNTY, SOUTH DAKOTA — SHEET NUMBER 64




N
2 280 000 FEET
R. 67 W.
(Joins sheet 56)
420 000 FEET
T. 117 N.
(Joins sheet 64)
(Joins sheet 66)
(Joins sheet 75)
410 000 FEET
2 300 000 FEET
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
0
¼
½
¾
1
1
2
3
4
5
6
7
8
9
10
11
12
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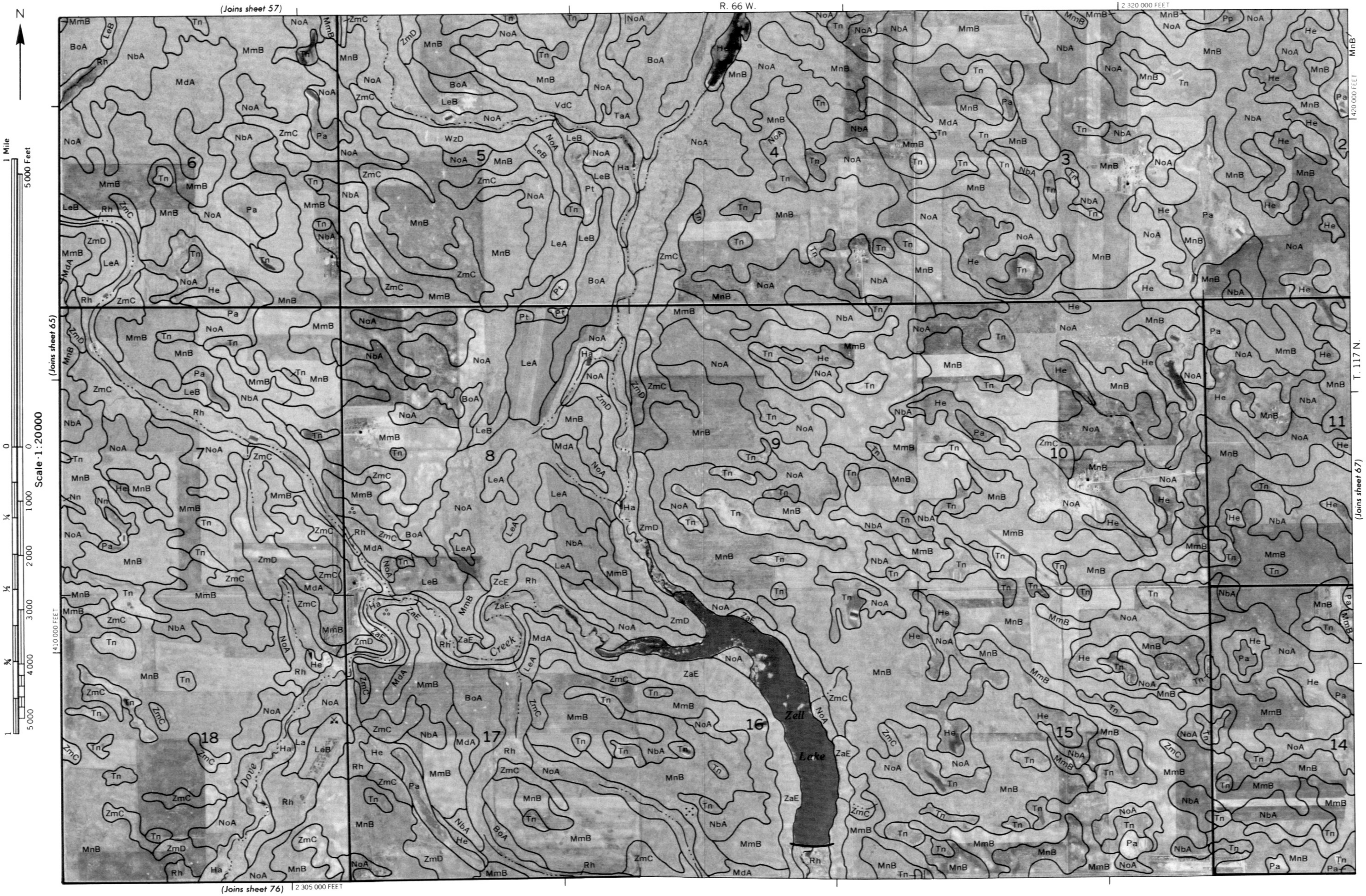
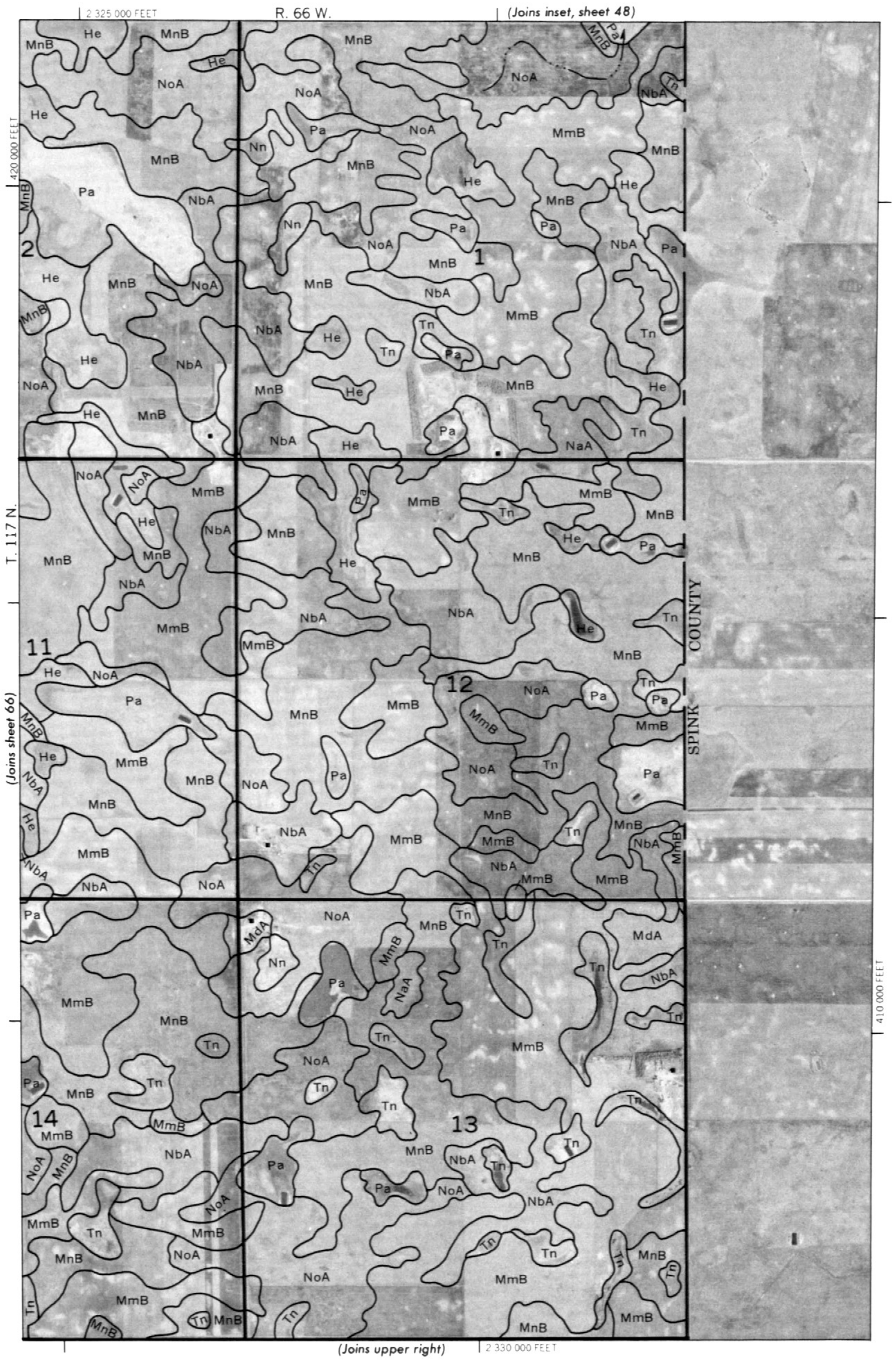
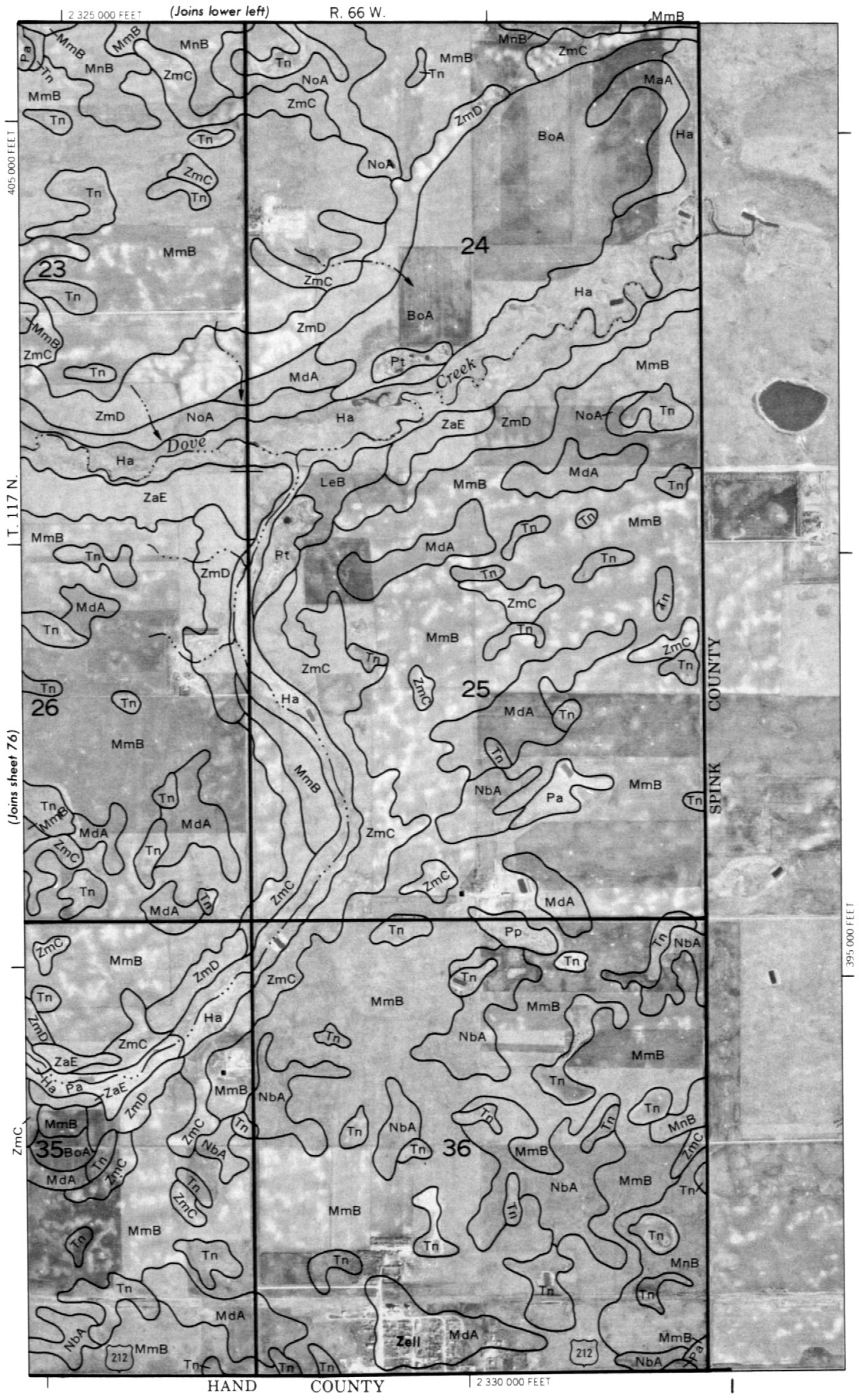
14
15
16
17
Dove
Creek
Dove
Creek
Creek
Ha
NoA
MnB
MmB
MdA
NbA
Tn
Pa
Pp
ZmC
ZmD
ZaE
LeA
LeB
BoA
Rh
He
Nn
Pt
TaB
WaD
w

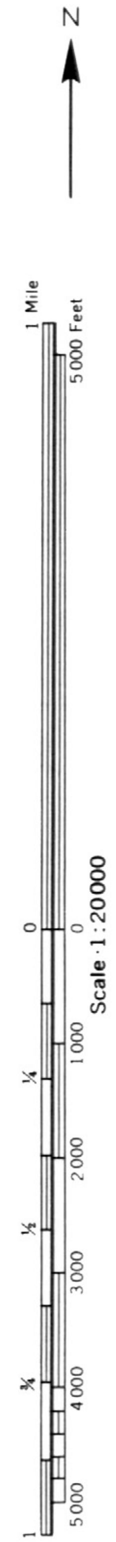
FAULK COUNTY, SOUTH DAKOTA — SHEET NUMBER 66



FAULK COUNTY, SOUTH DAKOTA — SHEET NUMBER 67

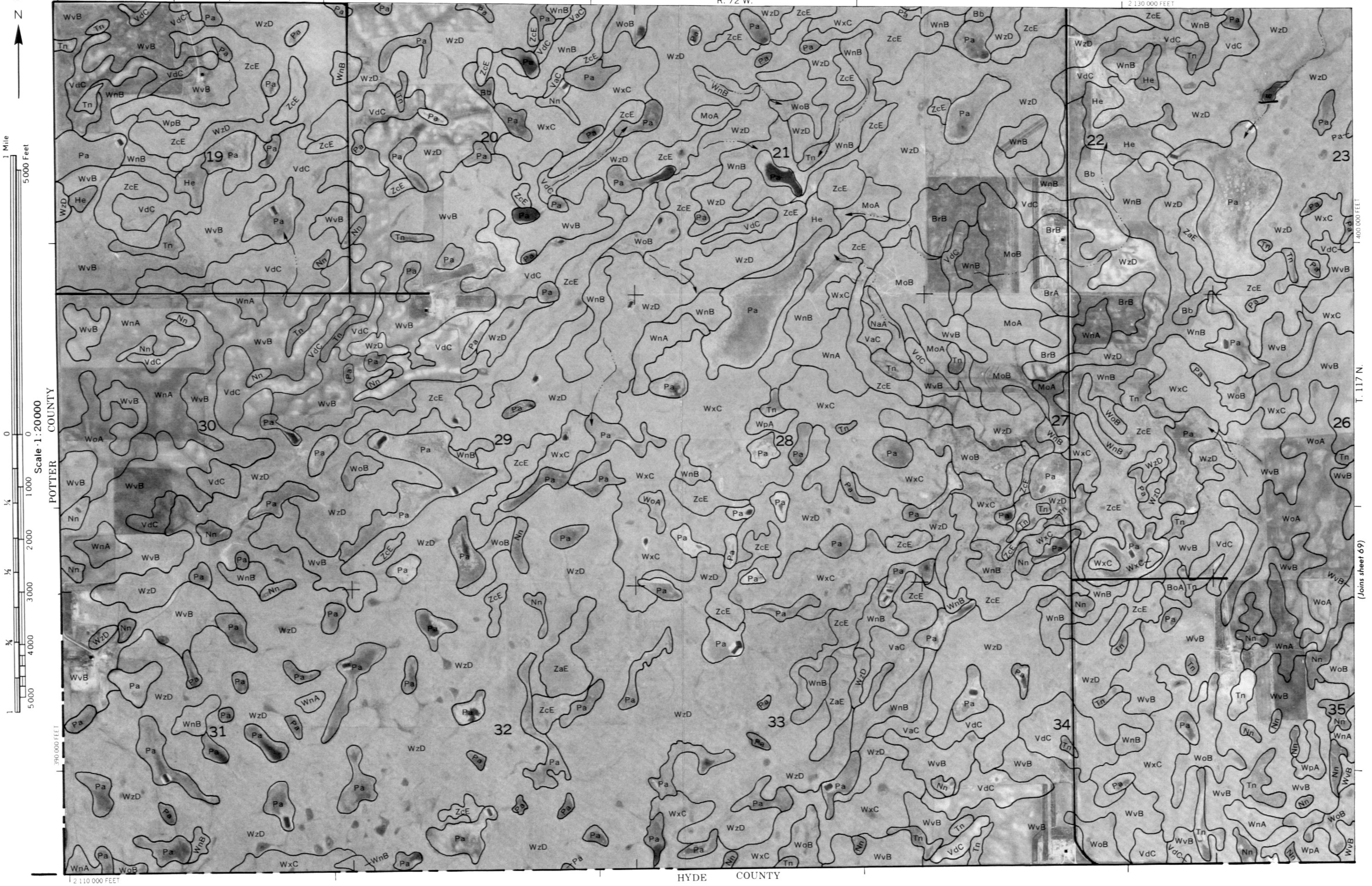




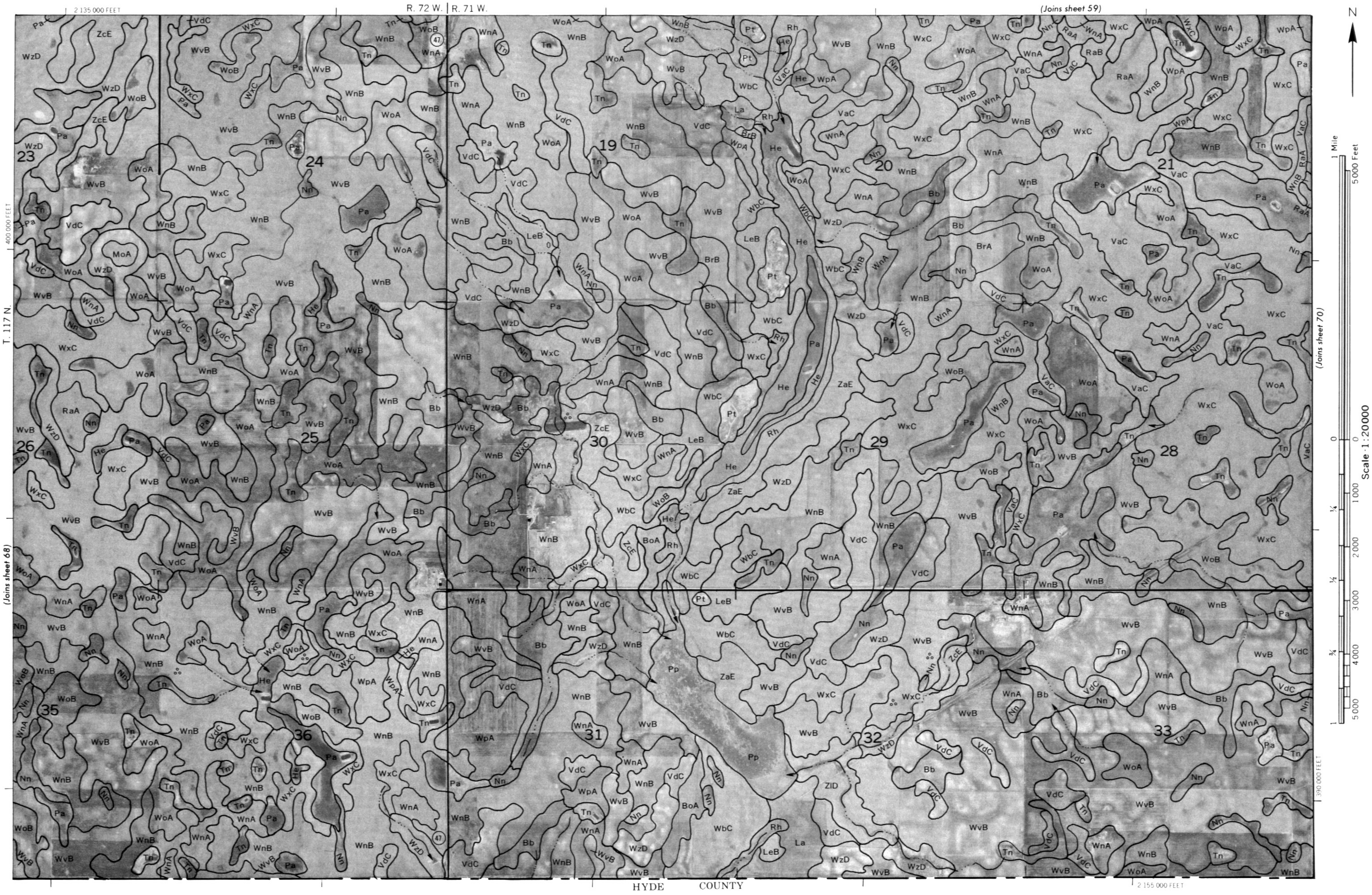


68

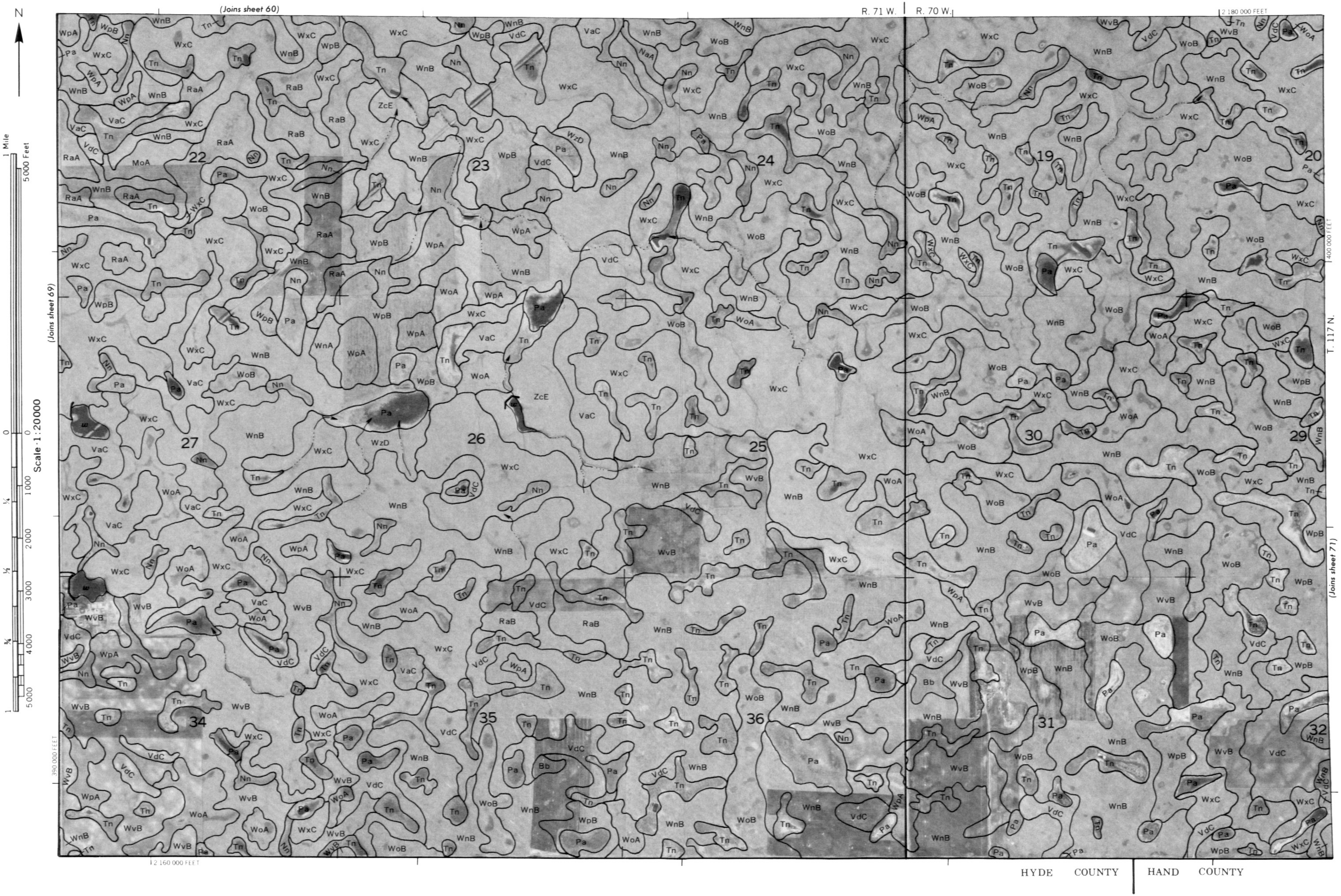
FAULK COUNTY, SOUTH DAKOTA — SHEET NUMBER 68



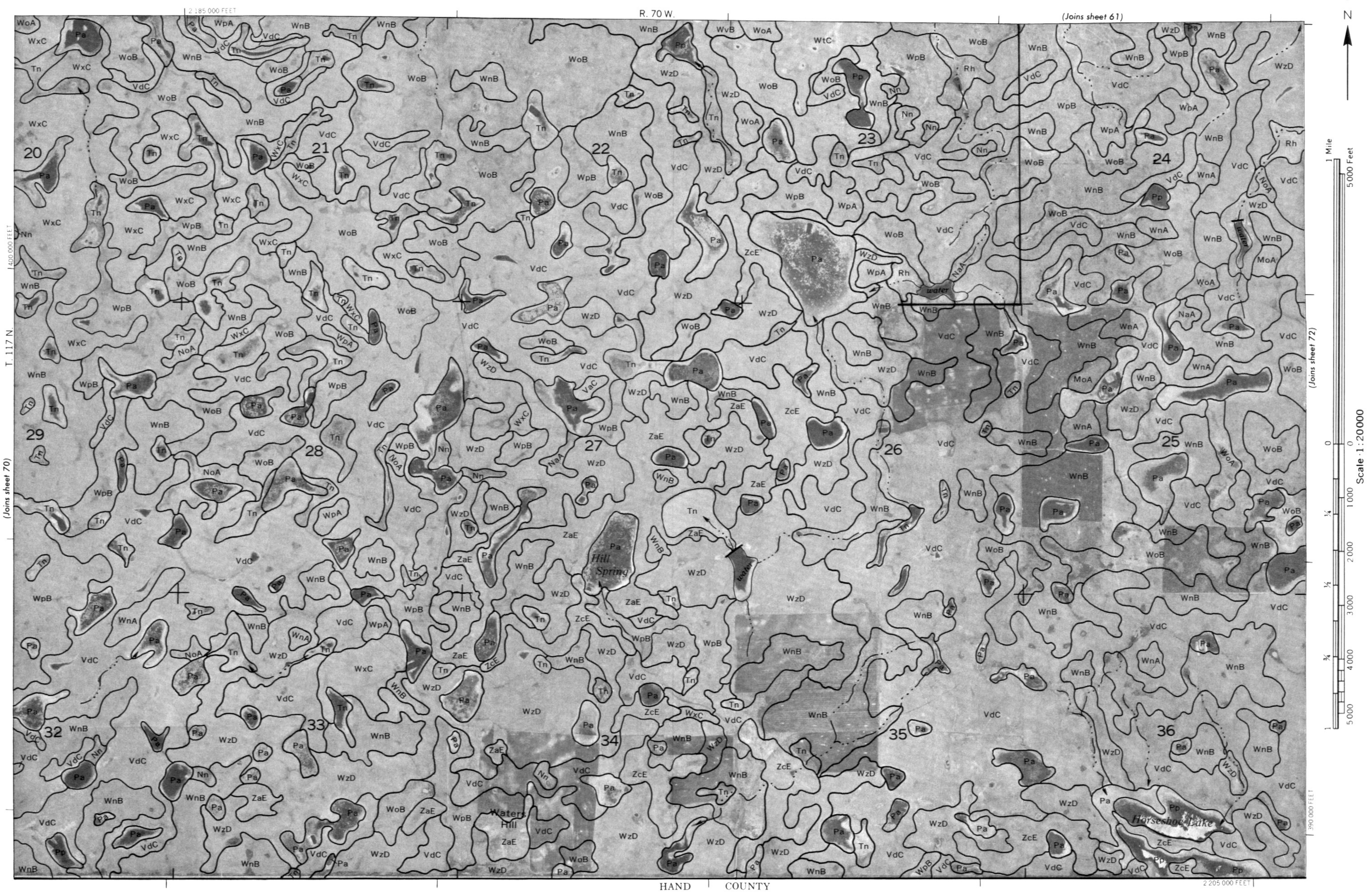
FAULK COUNTY, SOUTH DAKOTA — SHEET NUMBER 69



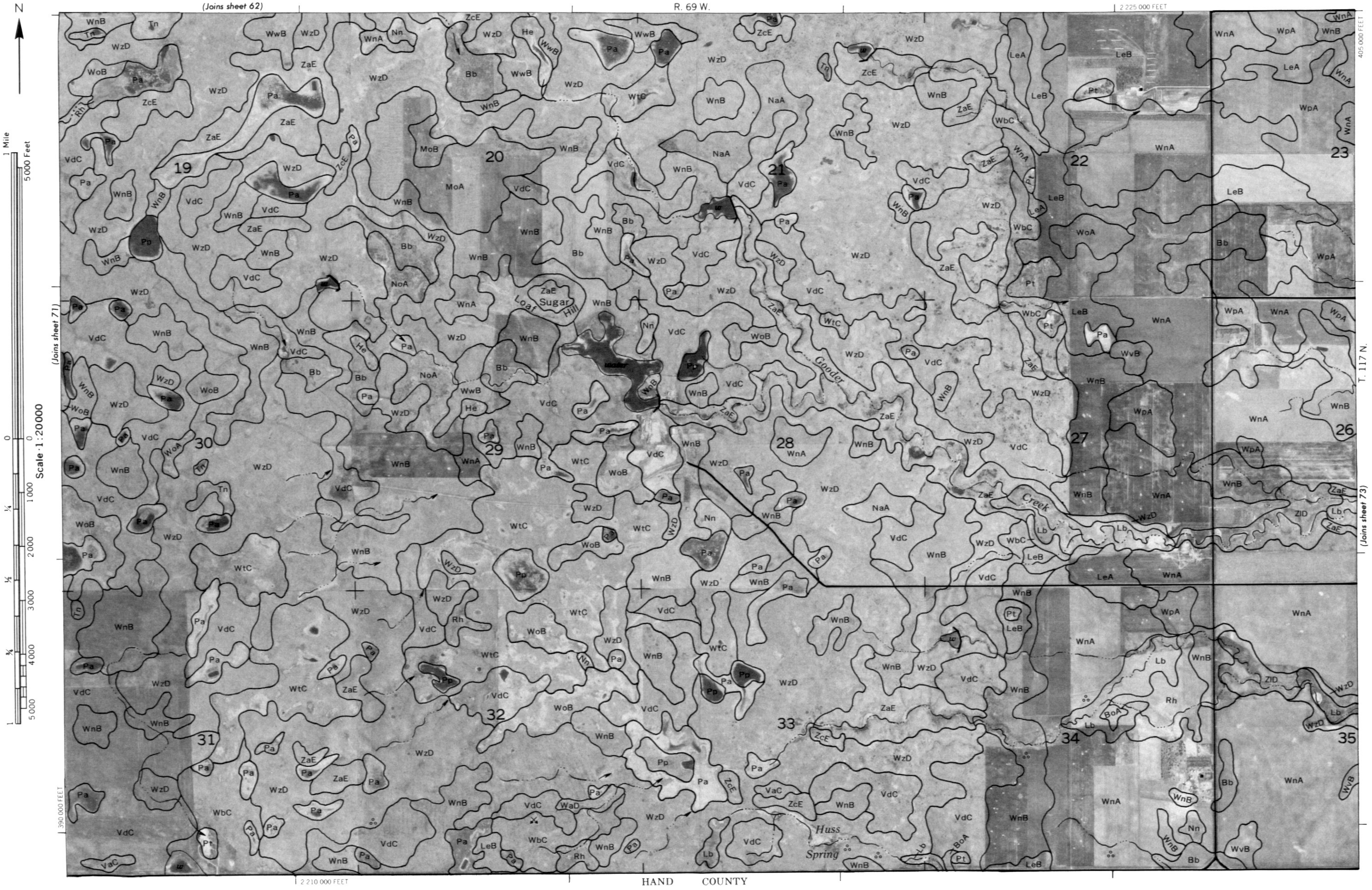
FAULK COUNTY, SOUTH DAKOTA — SHEET NUMBER 70



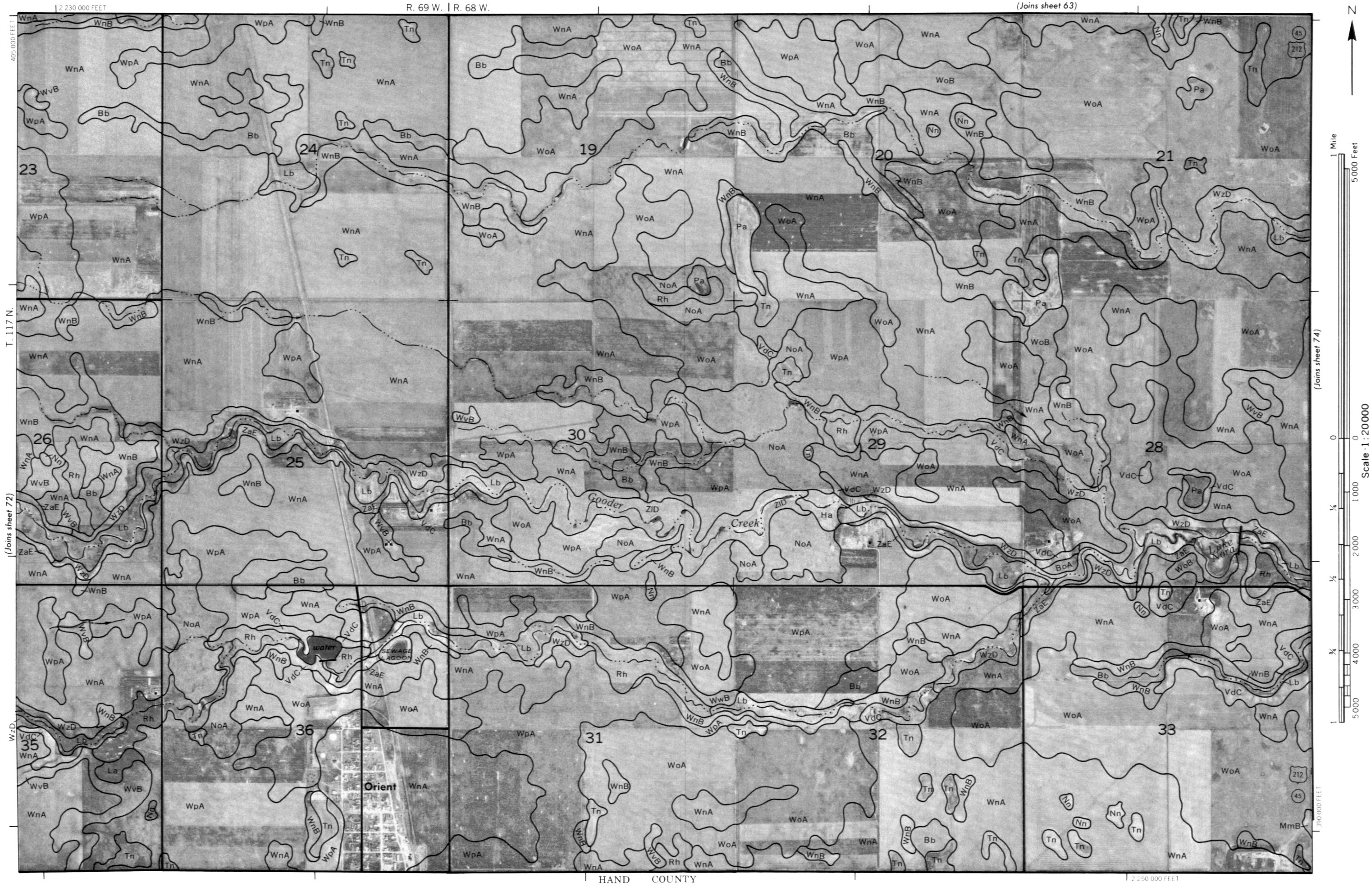
FAULK COUNTY, SOUTH DAKOTA — SHEET NUMBER 71



FAULK COUNTY, SOUTH DAKOTA — SHEET NUMBER 72

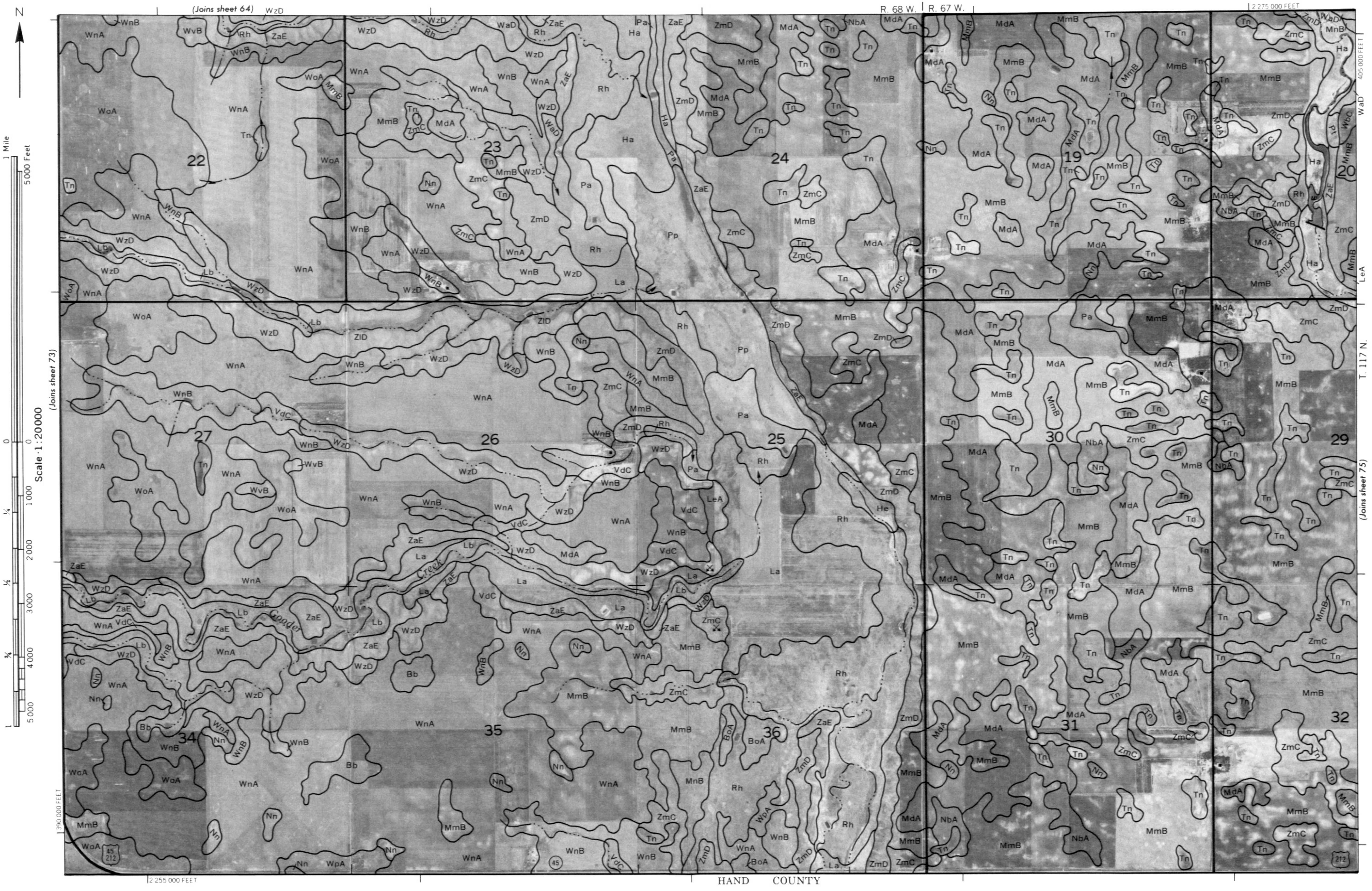


FAULK COUNTY, SOUTH DAKOTA — SHEET NUMBER 73

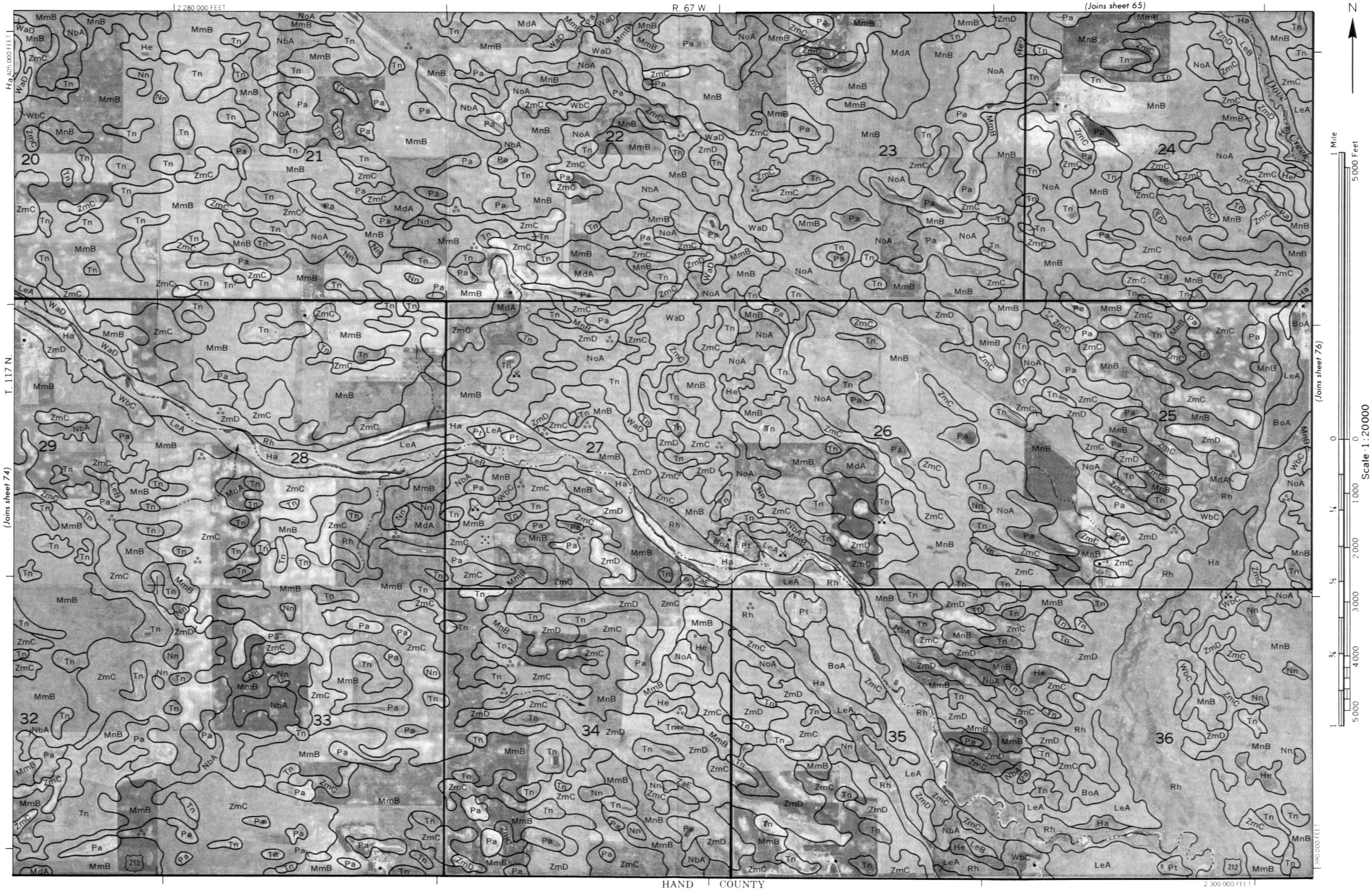


74

FAULK COUNTY, SOUTH DAKOTA — SHEET NUMBER 74



FAULK COUNTY, SOUTH DAKOTA — SHEET NUMBER 75



FAULK COUNTY, SOUTH DAKOTA — SHEET NUMBER 76